What matters for fertility in Bangladesh: natural disasters or mortality differentials, or both?

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Abstract

This study aims to examine whether disasters, differences in mortality rates, or both have influenced the total fertility rate (TFR) in the context of an increase in the number of disasters (floods and storms) in recent decades in Bangladesh. The study uses secondary data from available sources (EMDAT, World Bank, and others) for the number and type of disasters, mortality rates (neonatal, infant, male infant, and under-five mortality), and TFR. Regression analysis shows that the total number of disasters and individual disasters (extreme temperatures, floods, and storms) have a negative impact on TFR. For example, an increase in the number of floods leads to a decrease in average TFR. In terms of mortality indicators, under-five mortality, infant mortality, and male infant mortality have a significant positive impact on the TFR. However, an increase in contraceptive use has an impact on decreasing TFR. This result suggests that disasters have an inverse effect on TFR, but that children under age 5 who are more vulnerable in disaster-prone areas suffer more, leading to increased mortality, and will have an effect on TFR in the future due to an increase in the number of disasters.

Keywords: Bangladesh, Disaster types, Mortality Differentials, Total Fertility Rate (TFR)

1. Introduction and background

Natural disasters can affect fertility through several mechanisms, including infant mortality, displacement, access to reproductive health care, and the need for more children (Seltzer and Nobles, 2017). In terms of the relationship between natural disasters and fertility behavior, Nandi et al., (2018) in India and Lin (2010) in Italy found increased fertility after disasters such as the Indian Ocean earthquake and tsunami (Nobles et al., 2015). However, fertility also decreases after disasters such as the tsunami in Japan (Lin, 2010). Other studies, such as the Barreca et al., (2018) study on temperature change, the Louis (2014)' study on pollution, the Grace et al., (2015)' study on climate change and health outcome, and Arnocky et al., (2012) studies on changes in environmental factors such as forest resources, water levels, and declining land productivity, discuss how these factors affect fertility intentions and preferences. For example, increased environmental stress can influence fertility decline (Ghimire and Mohai, 2005).

Natural disasters have a range of direct and indirect effects on children's health and, consequently, on child mortality (Datar et al., 2012). In Bangladesh, for example, severe flooding in 1988 caused illness and death, especially among children under one year of age, and drowning was the leading cause of death among children aged 1-4 years (Hossain et al., 2015). Drowning rates are 10-20 times higher in Bangladesh than in other developing countries and much higher in disaster-prone areas (floods or cyclones) where rural populations are socioeconomically vulnerable (Hossain et al. 2015). In addition, people may die because they are exposed to external risk factors, including disasters, which can lead to increased child mortality. Mortality levels can interact with fertility (Cain, 1981; Preston, 1978). For example, people may choose to have more children in anticipation that some children will not survive due to the effects of a disaster

(Pörtner, 2008). On the other hand, the effects of disasters may also cause vulnerable people to reduce their future desire to have children. This is because people are often affected by disaster events and fear that they may lose their children in the future due to more frequent and natural disasters (Agadjanian & Prata, 2002).

Climate change is an important and increasingly concerning issue. The negative impacts of disasters are increasingly affecting all aspects of human life, including socioeconomic and demographic conditions (Grace, 2017; Ahmed et al., 2019). The relationship between natural disasters and fertility is complex (Hogan and Marandola, 2012; Millar and Pasta, 1995; Haq, 2013). Countries such as Bangladesh are vulnerable to climate variability and natural disasters (Jiang and Hardee, 2011). Several studies (e.g., Cleland et al., 1994; Caldwell et al., 1999; Haq, 2018) in Bangladesh have examined various factors that explain changes and trends in fertility. These studies have highlighted the socioeconomic and cultural factors that influence national differences in fertility and mortality. However, people's intentions to increase the number of additional children or reduce the number of children due to the effects of natural disasters and disaster-related mortality (e.g., neonatal, infant, and child mortality) can influence population size (Haq, 2018; Jiang and Hardee, 2011). As disasters increase due to climate change, the objective of this study was to examine how the types of natural disaster (e.g. floods and storms) and/or mortality affect fertility. Among natural disasters, floods and storms are very common in the country and are the focus of this study. Historical trends of floods and storms can provide a general picture of climate change vulnerability and thus fertility. This study aims to better understand the linkages between climate change, mortality, and fertility and provide important policy guidance to improve adaptive capacity and resilience to climate change impacts in Bangladesh.

The paper is structured as follows. The literature review includes the arguments and key findings of relevant studies that contribute to the research framework. The methodology section discusses the data sources, dependent and independent variables, and data analysis techniques. The study then presents the results based on the data analysis. In the conclusion, the main findings of this study are discussed and compared with other relevant studies, and then directions for future research are given.

2. Literature review

Several socioeconomic factors, such as education, income, poverty, empowerment and career opportunities, influence fertility. Therefore, many studies have identified the factors that influence fertility and gender preference in developing countries including Bangladesh. Therefore, this paper will examine how fertility is affected by different types of disasters, especially floods and storms and by mortality differences such as neonatal mortality, infant mortality, child mortality including male infant mortality. For this purpose, we review relevant literature below.

Changes in socioeconomic conditions are an important determinant of fertility changes (Hamamatsu et al., 2014). For example, in Bangladesh, the rich have the lowest desired number of children than the poor (Saha and Bairagi, 2007) and the number of children per woman decreases as monthly household income increases (Hasan and Sabiruzzaman, 2008). As a result of low socioeconomic conditions and poor nutritional status, infant mortality also increases, leading to higher fertility (Kabir et al., 2001; Sandberg, 2006). Moreover, disaster-related child mortality also affects fertility (Nobles et al., 2015), given the risk perception for the impact of disaster events in the future (Haq and Ahmed, 2019), having more children to replace the lost children (Finlay, 2009) as insurance against disasters (Cain, 1981; Frankenberg et al., 2015). For example, after the 2004 Indian Ocean tsunami, women who had lost one or more children had a strong preference to have more children. For example, women who did not have children before the tsunami also planned to have children in the near future after the event (Nobles et al., 2015). In conclusion experiencing the death of one's own child may prompt couples to try to get pregnant to replace the lost child (Preston, 1978; Qin et al., 2009). Poorer groups or countries are more vulnerable to natural disasters (Jiang and Hardee 2011) and may be inclined to have more children to replace those lost (Finlay, 2009).

Moreover, there may be differences in fertility due to different types of disasters such as storm and flood. For example, some conflicting findings show an increase in fertility (Cohan and Cole, 2002; Davis, 2017) and a decrease in fertility (Antipova and Curtis, 2015; Evans et al., 2010) after severe storms. Davis (2017) therefore concludes that it can take 4 to 6 years for fertility to normalize between disaster and non-disaster areas after a storm (Davis, 2017). In relation to flooding, Tong et al., (2011) show the changes in birth rate in North Dakota between pre-disaster (1994-1996) and post-disaster (1997-2000). The post-disaster birth rate dropped to 12.2 births per 1,000 population, compared to 13.1 pre-disaster births.

Several studies also show that there is a relationship between climate extremes such as temperature and precipitation and fertility. For example, higher temperatures reduce birth rates by about nine months in the United States (Barreca, 2017; Barreca et al., 2018). Cho (2020) finds that an additional day with a maximum temperature of 30-32°C compared to a temperature of 28-30°C decreases the birth rate in South Korea, implying that when controlling for education and age, there is a decrease in the number of pregnancies due to warm weather. The decrease could be due to heat-related fatigue, decreased sperm concentration, and poorer reproductive health of women at conception (Cho, 2020), but not to decreased sexual activity (Barreca et al., 2018). In

Indonesia, the intention to have another child is increasing and the use of family planning is decreasing in response to the delay in the onset of the monsoon in the previous year (Sellers and Gray, 2019). With high temperatures, women from poorer backgrounds are less likely to plan to have another child and more likely to use family planning (Sellers and Gray, 2019). In Mexico, Simon (2017) shows that the absence of migration after above-average rainfall may be an important factor for increased fertility in dry rural communities. In Bangladesh, Carrico & Donato (2019) showed that drought is associated with increased migration of male household heads, with farmers 40% more likely to migrate after a drought period than their counterparts engaged in other livelihood activities. Gray and Mueller (2012) concluded that floods have a minimal impact on population mobility in Bangladesh. However, when it occurs, it usually happens among the poor who live in a place that is more prone to flooding or inundation. This suggests that droughts and floods affect migration, which in turn may affect contraceptive use (Carta et al., 2012), and subsequently the fertility of vulnerable communities. For example, at the time of the 2009 earthquake in L'Aquila (a small Italian town), before the earthquake there were 109 couples who said they intended to have children, while after the earthquake the number of couples who planned to become pregnant increased to 156 (Carta et al., 2012). In addition, the number of women using contraceptives decreased from 87.14% to 72.59%, which was attributed to the desire to have children because of increased sexual desire, moments of physical intimacy and frequency of sexual intercourse after the earthquake (Carta et al., 2012).

3. Methods

3.1 Data source and study population

This study was conducted using publicly available secondary data from the International Disaster Database (EM-DAT) (https://www.emdat.be/). The Center for Research on the Epidemiology of Disasters (CRED) maintains the Emergency Events Database (EM-DAT) for natural disasters that have occurred since 1900. This EM-DAT database considers an event to be a disaster when it incorporates at least 10 deaths, 100 people affected, or when the affected area is declared a state of emergency and requires international assistance. For each disaster, EM-DAT provides information on the location of the disaster, the type of disaster (i.e., drought, earthquake, epidemic, extreme temperatures, floods, mass movement, storms, and wildfires), the start and end dates, and the damage caused (i.e., deaths, injuries, and homelessness, as well as estimated losses). This database has been used extensively in disaster-related public and child health and economics research (Datar et al., 2012). This disaster database can be accessed for free by registering and logging into a user account for non-commercial purposes. We downloaded disaster records for Bangladesh from 1966 to 2018 using a simple data query tool. The information collected by EM-DAT was mainly from UN agencies, government departments, the International Federation of Red Cross and Red Crescent Societies, and research and insurance companies.

Disaster events that occurred in Bangladesh between 1966 and 2018 were included in this study. The unit of analysis is the year in which the disaster event occurred. Climatic, hydrological and meteorological hazard events were recorded for each year. The major hazard types were drought, temperature extremes (heat waves and cold waves), floods (flash floods and river floods), landslides, mudslides, cyclones and storms. Data on fertility and other indicators such as total fertility rate, contraceptive prevalence, neonatal mortality, infant mortality, male infant mortality, and under-five mortality were collected from the World Bank database (https://data.worldbank.org/). This study was exempted from ethical scrutiny because we used publicly available de-identified data.

3.2 Outcome variable

The main outcome variable in this study is the total fertility rate (TFR). The TFR is the number of children a woman would have if she lived to the end of her reproductive years and gave birth at an age-specific fertility rate for a given year. The TFR is based on data on registered live births from vital registration systems or, in the absence of such systems, from censuses or sample surveys. The estimated rate is usually considered to be a reliable measure of the most recent fertility rate. If empirical information on age-specific fertility rates is not available, a model is used to estimate the share of adolescent births. For countries without vital registration systems, fertility rates are generally extrapolated from trends observed in earlier censuses or surveys. The World Bank has compiled data on total fertility in Bangladesh from the United Nations Population Division.

3.3 Predictors

Several different predictors were considered in the analysis. The variables associated with disasters are the [number of deaths, injuries, number of people affected, and number of homeless] per year, and the total number of people affected by the disaster. The climate event-related variable is the total number of disasters that occurred each year from 1966 to 2018. We also considered individual records of floods, storms, and extreme temperature events. Flood types include subtypes of coastal, flash floods, and riverine floods. The subtypes of storms are convective and tropical cyclones. Extreme temperature events define cold waves, heat waves, and severe winter conditions. The predictors related to fertility were selected based on published literature. These factors are neonatal mortality, under-five mortality, infant mortality, crude mortality, life expectancy at birth, male infant mortality, carbon dioxide emissions (metric tons per capita), gross national income per capita (by Atlas method), contraceptive prevalence rate (CPR), female labor force participation, and male labor force participation. However, in the present study, disasters, disaster types, neonatal mortality, infant mortality, male infant mortality and under-five mortality, CPR and other variables were excluded from each of the final models due to a very high degree of collinearity.

3.4 Statistical analysis

Descriptive statistics (i.e., mean, standard deviation, and interquartile range) were used for continuous variables. For categorical variables' frequencies and percentages were calculated; Chi-square and/or Fisher's exact tests were used to assess associations between categorical variables. Bivariate and multivariate linear regression models were used to identify significant predictors of TFR. First, we used the bivariate regression models for the outcomes and each predictor. An arbitrary p-value of 0.20 was used to assess the criteria for including covariates in the multivariate model to control for confounding effects. For the multivariate regression models, we report the regression coefficient estimates, standard errors, p-values, and 95% confidence intervals (CIs). We used five different models to predict the outcome variable (TFR) with the total number of disasters as the key predictor variable, and then we calmly included other predictors in each model. In the first model, we included under-five mortality (both sexes), the second model included neonatal mortality, the third model included infant mortality, the fourth model included male infant mortality, and the fifth model included CPR. The analyses were performed in Stat 15.0 (StataCorp LP, College Station, Texas).

4. Results

4.1 Trends in independent and dependent variables

From 1960 to 2018, Bangladesh experienced several historical disasters, including climate hazards. **Annex 1** shows that from 1900 to 2018, several disasters have been recorded. Floods and storms are the main types of disasters or climate hazards, and the country faces the disaster types frequently. Where river floods and tropical cyclone were more common than other types of disasters. Both disasters affected a large number of residents and caused huge damage. **Annex 2** shows that the number of disasters in the last decade has decreased compared to the previous two decades from 1990 to 2010. The total number of disasters in the last three decades was more than ten.

Annex 3 shows the fertility trends in Bangladesh from 1966-2020. The TFR fell from 7 (children per woman) in 1966 to 2.1 (children per woman) - the replacement level in 2018. The country managed to reduce total fertility by one per woman between 2000 and 2018 and that the dramatic drop in fertility rate makes Bangladesh an example of a successful case. **Annex 3** also shows that the contraceptive prevalence rate (CPR) began to rise almost from zero in the 1980s and exceeded 50% in the late 00s. In addition, the CPR was between 50 and 60% for almost 20 years, and then exceeded 60% around 2015. The trends for the TFR and the CFR indicate that the TFR has declined as the CPR has increased. **Annex 3** also shows that life expectancy at birth has increased while the crude death rate has decreased: in 2018, life expectancy at birth was about 73 years and the crude death rate was about 5 per 1,000 population.

Regarding infant mortality, **Annex 4** shows that infant and male infant mortality fell to below 50 per 1,000 live births around 2005 and is about 25 per 1,000 live births in 2018. In addition, neonatal mortality and under-five mortality (for both sexes) declined almost to 25 per 1000 live births in 2018. Moreover, neonatal mortality declined faster than other mortality.

4.2 Descriptive statistics of selected variables

Table 1 presents descriptive statistics for the selected variables. The average number of natural disasters was 5.26; this means that Bangladesh has an average of five disasters per year, with a maximum of 12. The average TFR is 4.42, with a maximum of 6.95 between 1969 and 1970 and a minimum of 2.04 in 2018. The Contraceptive Prevalence Rate (CPR) shows that the minimum CPR was 7.7% and the maximum CPR was 62.4%. The lowest mortality rates were for neonates and children under five years of age, with 17.1 and 30.2 cases per 1000 live births, respectively. The highest neonatal and under-five mortality rates were 94.9 and 230.2, respectively. The lowest infant mortality rate was 25.6 and the highest 153.3 per 1000 live births. The highest male infant mortality rate was 164.6 and the lowest 27.3 per 1000 live births. This means that the country has been able to reduce fertility and mortality rates while contraceptive prevalence has gradually increased.

4.3 Univariate effect: predictors and TFR

Table 2 shows the regression coefficients of variables predicting changes in TFR. The results show that all predictors were significant in explaining changes in TFR. To understand their effects on TFR, we considered the total number of disasters and the individual disaster elements separately. The total number of disasters had a significant negative relationship with TFR. The effect is negative and significant when we look at the individual disasters. Extreme temperature has the highest coefficient compared to other individual disasters and selected predictors. The average fertility decreases by 1.17 units when the extreme temperature event increases in one unit. Several indicators of infant mortality had positive and significant effects on TFR. Of the mortality indicators, neonatal mortality had the largest effect. For example, fertility increases by 0.067 for an increase in neonatal mortality, while it increases by 0.026, 0.041, and 0.038 for under-five mortality for both sexes, infant mortality, and male mortality, respectively. Moreover, one unit increase in CPR is associated with a negative change in TFR of 0.085 units, $P<.05$.

4.4 Multivariable effects: predictors and TFR

Several regression models had been run to understand how total disasters and other potential variables such as neonatal, infant and son mortality, under-five mortality and contraceptive prevalence affected total fertility. We sought to understand the interaction between total disasters and other variables, and therefore fixed the variable in each model and included other variables. We also examined the separate effects of mortality, such as under-five mortality for both sexes, neonatal mortality, infant mortality, and male infant mortality. The results of the regression models show that all types of mortality have a positive effect on TFR (see **Table 3**). However, model 2 shows that the coefficient on neonatal mortality is higher than other types of mortality compared to models 1, 3 and 4.

Table 4 presents regression models for individual disasters such as extreme temperature events, floods and storms with other potential variables for child mortality and TFR. Models 1 to 4 show a consistent negative effect of each individual disaster on TFR. Similar to the previous models described in **Table 3**, the models in **Table 4** show significant positive effects of under-five mortality, neonatal mortality, infant mortality and male mortality on TFR.

The predictors included in Model 1 were significant in explaining trends in TFR. TFR decreases by 0.0956, 0.0524 and 0.0242 for each increase in extreme temperature, flood and storm, respectively. However, fertility increases with increasing under-five mortality for both sexes by .0255. Models 2, 3 and 4 show similar results for the effect of predictors on TFR. For Models 1-4, the largest impact on TFR is due to an extreme temperature event. This means that extreme temperature events have a greater impact on the TFR than other single disasters such as floods and storms. Infant mortality has the highest coefficient (.0649) compared to other mortality indicators, explaining its impact on TFR when other individual disaster predictors were included. The results of Model 5 are very different from the other four models. The effect of each individual disaster becomes positive when CPR was included in the Model. However, the effects of extreme temperatures and floods are not significant. Fertility increases with increasing number of storms and decreases with increasing CPR.

5. Concluding discussions

This study examines whether TFR differs by disaster type and mortality in Bangladesh. Since the trends in TFR show a dramatic decline and a gradual increase in CPR in the last two-three decades. Moreover, the mortality rate of newborns, infants, male infants and children under five years of age has been declining in the country. On the other hand, with a gradual increase in different types of disasters, especially floods and storms, the country is experienced with the adverse effects of the disasters. In this regard, the current study unravels the impact of different types of disasters and mortality on the overall fertility rate.

The results from statistical analysis show that the number of disasters and individual disasters, such as floods and storms, are negatively correlated with TFR. This means that more frequent floods (very common in Bangladesh) contribute to a decrease in TFR. This result is consistent with a study by Tong et al., (2011) in the United States. Tong et al., (2011) showed that the Red River flood in 1997 was associated with a post-flood decline in fertility (e.g., from

13.1 births to 12.2 births per 1,000 population). Moreover, in addition to disaster crises, there is evidence that fertility declined after crises in Eritrea and Tajikistan (Blanc, 2004; Clifford et al., 2010) and after famines that led to extreme food shortages (Fellman and Eriksson, 2001). For example, the present study shows a higher degree of negative change in fertility rates with an increase in floods than with storm events. This may be because floods are frequently and extensively reported in terms of impact compared to storms across the country.

Although the present study did not analyze the impact of disasters on fertility before and after the disasters. Nevertheless, there was an increase in fertility during post-disaster periods (Cohan and Cole, 2002; Davis, 2017). Conversely, fertility decreased after heat waves or extreme temperatures (Lam and Miron, 1996; Helle et al., 2008; Cho, 2020; Sellers and Gray, 2019; Barreca et al., 2018). However, a study by Haq and Ahmed (2019) in Bangladesh found that women in areas highly affected by floods and cyclones preferred higher fertility rates than those in regions not affected by disasters. This means that infant mortality, especially neonatal and male infant mortality due to disasters, may increase fertility. This may be because people prefer to have children because they want to have at least one child to replace one or more children who have died, and because one or more male children is a hedge against future crises from severe natural disasters.

In this regard, this study has very significant results regarding the effect of different mortality indicators on total fertility rate. It finds that neonatal, infant, male infant and under-five mortality contribute to an increase in total fertility rate. The higher coefficient on neonatal mortality suggests that people tend to have more children in the short run, as they consider it better to have at least one or more children or more if they lose one child. However, the TFR is negatively related to the total number of disasters, but the increasing number and severity of disasters may influence higher neonatal mortality. The findings are consistent with those of other studies such as Finlay (2009) in India, Kabir et al., (2001) in Bangladesh, and Sandberg (2006) in Nepal. The studies argued that families might tend to produce more children to replace those lost. This is due to the consideration of having insurance against the negative impacts of natural disasters (Frankenberg et al., 2015; Nobles et al., 2015). A recent study has already shown that families with damaged homes use temporary storm shelters when the male family members spend their time repairing their damaged homes and the women often spend most of the day in the shelters in Bangladesh (Ahmed at al., 2019; Miyaji et al., 2020). This result also implies that the impact of disasters in highly disaster-prone areas may contribute to an increase in fertility due to high preference for male children (Haq, 2018). This may be because more male children provide insurance and a helping hand during crises and afterwards to recover from damages (Haq, 2013).

The present study also looked at the impact of contraceptive prevalence rate (CPR) on fertility rates and found a negative association between the two factors. Although the magnitude of the impact of CPR varied, it was statistically significant for the interaction with total number of disasters, floods, storms, and various mortality indicators considered in the study. Interestingly, the result showed different results for individual disasters such as floods and storms, while CPR was included in the multivariate analysis. For all cases, CPR was negatively associated with TFR and total number of disasters was negatively correlated with TFR. The inclusion of CPR in Model 5 leads to a different effect on TFR than the effect of the total number of disasters. However, the coefficients for the interaction between individual disasters and TFR became positive when CPR was included in the model. Model 5 shows that the TFR increases when the total number of disasters increases and decreases when CPR increases. This implies that the absence or low use of contraception in disaster-prone areas could lead to an increase in fertility. There is a study by Haq (2018) in flood-prone areas in the northeastern region of Bangladesh that shows high fertility prevalence and low contraceptive use. Other studies, such as Carta et al., (2012) in Italy, which examined the relationship between an earthquake and fertility, showed a lower number of women using contraceptives after the disaster. This implies that total fertility would decrease with an increase in contraceptive prevalence rates (Bongaarts, 1978; Bongaarts, 2017). On the other hand, lack of access to contraception during periods of floods and storms due to lack of communication interruptions and poor access to contraceptives may affect fertility in Bangladesh.

Therefore, there are many studies showing rural-urban differences and regional variations in fertility (Kabir et al., 2009), mortality, and contraceptive prevalence rates in Bangladesh. For example, NIPORT et al., (2016) and Alam et al., (2018) show regional differences in contraceptive prevalence rates (e.g., lower contraceptive use in Sylhet and Chattogram Division than in Rajshahi and Khulna) and total fertility rates (high fertility in Sylhet and Chattogram Division than in Rajshahi and Khulna). Alam et al., (2018) identified factors such as family planning attitudes, social influence, decision making, fertility preferences, and women's empowerment that affect fertility. However, there is limited information to study the influence of disasters and disaster types on fertility considering the impact of the different types of child mortality and contraceptive prevalence rate for Bangladesh.

In this regard, the current study has shown the effect of very common disasters such as floods and storms and the breakdown of mortality by neonatal mortality, infant mortality, male infant mortality and under-five mortality on fertility. The results show that the country has experienced many disasters and they have resulted in fatalities, economic losses and livelihood problems. The disasters were involved in the disruption of income-generating activities of vulnerable populations due to damage to the main agricultural production, particularly rice (Sarker et al., 2013). However, the country has managed to reduce the fertility rate to near replacement level, but for several mortality indicators (neonatal mortality, infant mortality, male mortality, and under-five mortality) the country still needs to make efforts to reduce these rates in the coming years. The number of disasters with serious consequences is increasing and they affect a large proportion of the population of Bangladesh. This may contribute to an increase in the mortality rate at different levels in the country.

Deciphering the underlying relationship between disasters, mortality and fertility through cross-national comparison will provide a detailed understanding and have broader implications in the era of very rapid climate change and increasing natural disasters. Also, exploring the nexus through a detailed qualitative study in different disaster-prone areas in developing countries, including Bangladesh, will improve the understanding of the nexus between disasters, mortality and fertility by building a theoretical and conceptual model that can be used for future studies in areas with climatic uncertainties.

Disclosures/Conflict of Interest: There are no potential conflicts (financial, professional, or personal) to disclose by any of the authors.

Funding: The authors did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Availability of data and material: All data presented here in the manuscript is freely available at EM-DAT, World Bank, and UN.

Code availability: Maybe available by contacting corresponding author.

Ethics approval: This study was exempt from the ethical review approval as we used publicly available de-identified data.

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Tables:

Table 1 Sample characteristics

Variables	N	Mean	Median	SD	Minimum	Maximum
Total number of disaster	54	5.26	5	2.68	0	12
Total fertility rate	52	4.42	4.07	1.83	2.04	6.95
Contraceptive prevalence rate	31	45.67	52.64	16.01	7.7	62.4
Neonatal Mortality	52	58.92	58.2	27.04	17.1	94.9
Under five mortality	52	131.01	128.7	69.37	30.2	230.2
Infant mortality	53	89.63	88.4	44.35	25.6	153.3
Male infant mortality rate	53	95.84	94.7	47.55	27.3	164.6

Table 2 Univariate regression coefficient predicting total fertility rate (TFR)

Variables	β Coefficient	SE	t	p-value	95 % CI	
Total number of disasters	-0.345484	0.08225	-4.2	<0.001	-0.51069	-0.18028
Extreme temperature	-1.176515	0.350055	-3.36	0.001	-1.87962	-0.47341
Flood	-0.644639	0.213258	-3.02	0.004	-1.07298	-0.2163
Storm	-0.351564	0.139415	-2.52	0.015	-0.63159	-0.07154
Under five (U5) mortality both sex	0.026332	0.000322	81.67	<0.001	0.025684	0.026979
Contraceptive prevalence rate (CPR)	-0.085133	0.002733	-31.15	<0.001	-0.09072	-0.07954
Neonatal mortality	0.067474	0.000943	71.58	<0.001	0.065581	0.069367
Infant mortality rate	0.041611	0.000566	73.5	<0.001	0.040474	0.042748
Male infant mortality rate	0.038805	0.000541	71.76	<0.001	0.037719	0.039891

Table 3 Regression on total fertility rate by total number of disasters and other characteristics

Variables	β-coefficient	Std. Err.	t	p-value	95% CI	
Model-1						
Total number of disasters	-0.0393	0.0076	-5.18	<0.001	-0.0545	-0.024
Under five (U5) mortality rate both sex	0.0256	0.0003	86.52	<0.001	0.025	0.0262
Model-2						
Total number of disasters	-0.0489	0.0081	-6.06	<0.001	-0.0651	-0.0327
Neonatal mortality rate	0.0652	0.0008	80.69	<0.001	0.0636	0.0669
Model-3						
Total number of disasters	-0.0438	0.0084	-5.24	<0.001	-0.0605	-0.027
Infant mortality rate	0.0404	0.0005	78.18	<0.001	0.0393	0.0414
Model-4						
Total number of disasters	-0.0441	0.0086	-5.11	<0.001	-0.0614	-0.0267
Male infant mortality rate	0.0376	0.0005	75.65	<0.001	0.0366	0.0386
Model-5						
Total number of disasters	0.0542	0.0148	3.67	0.001	0.0239	0.0845
Contraceptive prevalence rate	-0.0885	0.0025	-35.91	<0.001	-0.0936	-0.0835

Table 4 Regression on total fertility rate by individual disaster and other characteristics

Variables	β-coefficient	Std. Err.	t	p-value	95% CI
Model-1					

Extreme temperature	-0.0956	0.0283	-3.37	0.002	-0.1526	-0.0386
Flood	-0.0524	0.0188	-2.79	0.008	-0.0901	-0.0146
Storm	-0.0242	0.0118	-2.05	0.046	-0.0479	-0.0004
Under five (U5) mortality rate both sex	0.0255	0.0003	88.69	<0.001	0.0249	0.0261
Model-2						
Extreme temperature	-0.1152	0.0305	-3.78	<0.001	-0.1765	-0.0539
Flood	-0.0546	0.0202	-2.7	0.01	-0.0952	-0.0139
Storm	-0.0345	0.0127	-2.72	0.009	-0.0601	-0.009
Neonatal mortality rate	0.0649	0.0008	82.26	<0.001	0.0633	0.0665
Model-3						
Extreme temperature	-0.1041	0.0314	-3.32	0.002	-0.1672	-0.041
Flood	-0.0593	0.0208	-2.86	0.006	-0.1011	-0.0175
Storm	-0.0267	0.0131	-2.04	0.047	-0.053	-0.0004
Infant mortality rate	0.0401	0.0005	80.01	<0.001	0.0391	0.0411
Model-4						
Extreme temperature	-0.1072	0.0324	-3.31	0.002	-0.1723	-0.0421
Flood	-0.0593	0.0214	-2.76	0.008	-0.1024	-0.0161
Storm	-0.0269	0.0135	-2	0.052	-0.0541	0.0002
Male infant mortality rate	0.0374	0.0005	77.46	<0.001	0.0364	0.0384
Model-5						
Extreme temperature	0.0728	0.0473	1.54	0.136	-0.0244	0.17
Flood	0.015	0.0329	0.45	0.653	-0.0527	0.0826
Storm	0.0787	0.0213	3.69	0.001	0.0349	0.1225
Contraceptive prevalence rate	-0.0886	0.0023	-38.74	<0.001	-0.0933	-0.0839

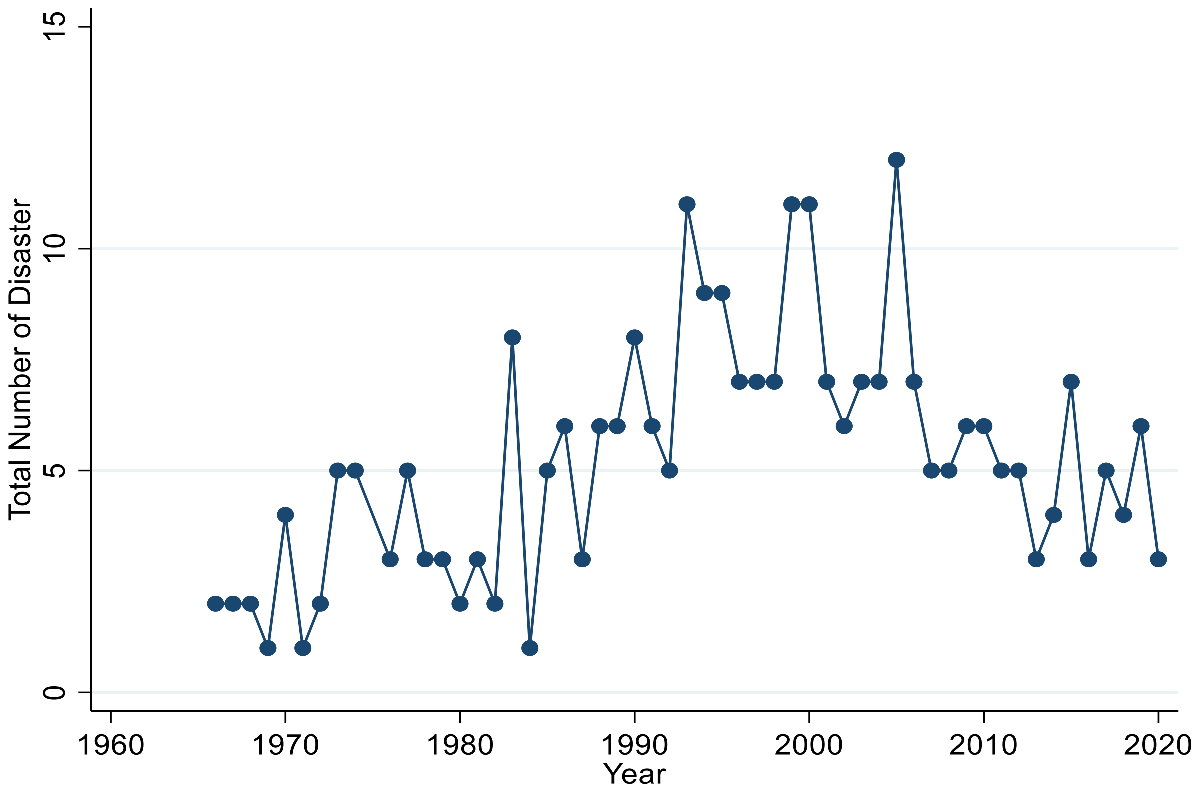
Annexes:

Annex 1 Disaster records for Bangladesh, 1900–2018

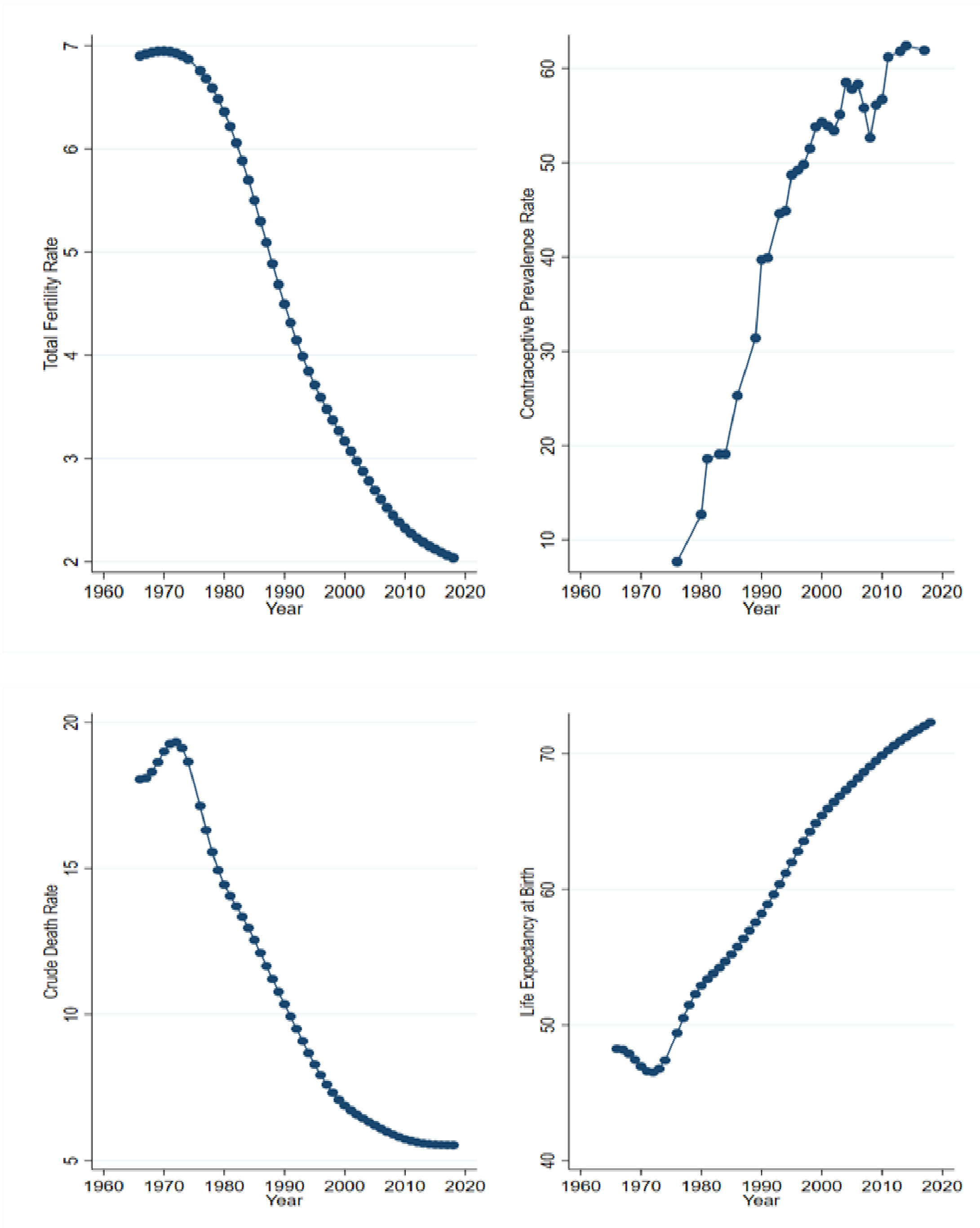
Disaster type	Disaster sub-type	Count of events	Total deaths	Population affected	Total damage (USD x 1000)
Drought	Not specified	7	1,900,018	25,002,000	-
Earthquake	Ground movement	8	43	19,395	-
	Tsunami	1	2	-	500,000
Epidemic	Not specified	17	5,068	2,503,118	-
	Bacterial disease	6	3,654	421,268	-
	Parasitic disease	3	1,396	69,904	-
	Viral disease	5	393,085	48,928	-
Extreme temperature	Cold wave	19	2,182	313,200	-
	Heatwave	2	62	-	-
	Severe winter conditions	2	230	101,000	-
Flood	Not specified	35	45,026	185,490,392	4524100
	Coastal flood	2	51	473,335	-
	Flash flood	11	261	7,634,577	729000
	Riverine flood	46	7278	138,644,785	7763300
Landslide	Not specified	4	103	56,283	-
	Mudslide	1	160	80,187	-
Storm	Not specified	49	5,706	2,356,857	850,000
	Convective storm	39	2,153	1,470,091	40,401
	Tropical cyclone	89	626,943	82,168,734	5,405,979

Data source: EM-DAT (2018)

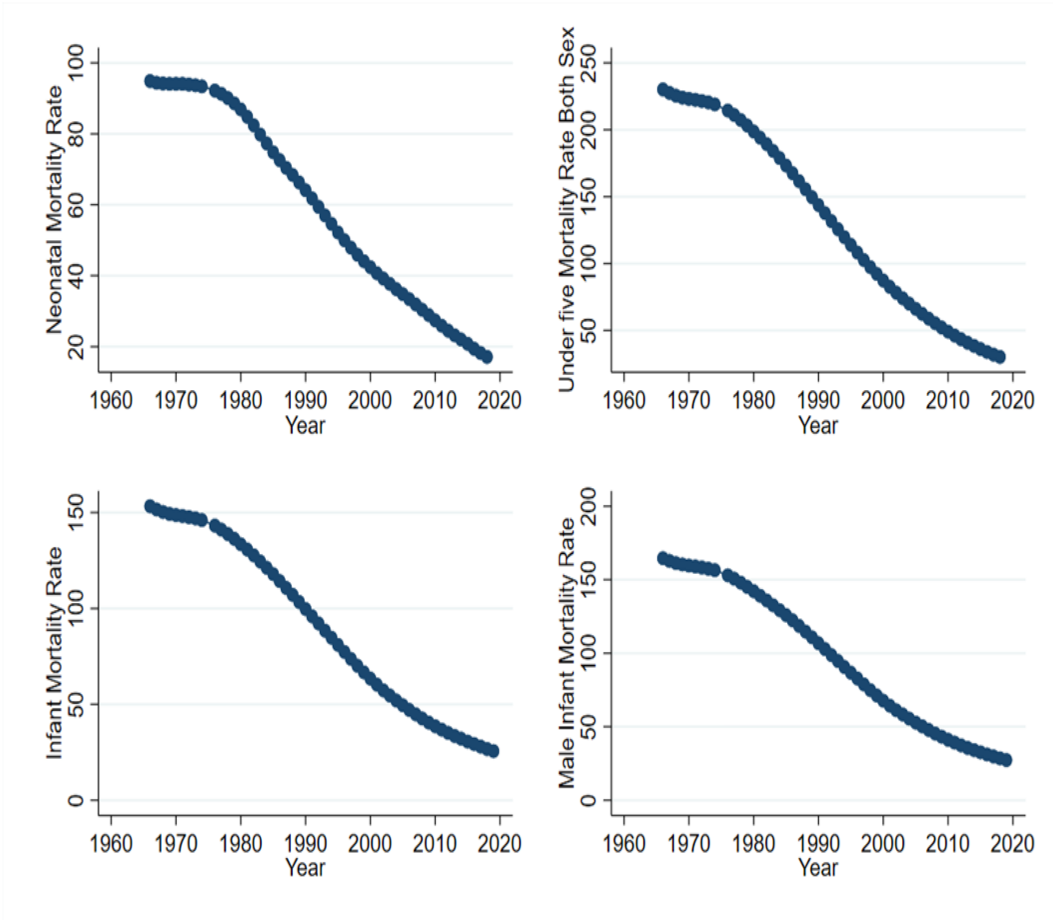
Annex 2 Disaster records for Bangladesh, 1960–2018



Annex 3 Trends of TFR, CPR, CDR and Life Expectancy for Bangladesh, 1960–2018



Annex 4 Trends of Neonatal, infant, male infant and under-five mortality rate for Bangladesh, 1960–2018


Neonatal Mortality Rate
Under five Mortality Rate Both Sex
Infant Mortality Rate
Male Infant Mortality Rate
Year