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The impact of extreme weather events on fertility preference and gender preference in Bangladesh

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The link between population dynamics and climate-related severe events is complicated. Extreme weather events (EWEs), along with other factors such as socioeconomic and cultural factors, influence population dynamics, particularly changes in fertility, mortality, and migration. This study focuses solely on the fertility aspect of climate change and aims to investigate it in Bangladesh, which is extremely sensitive to climate change and EWEs such as floods, cyclones, and droughts. On a regular basis, the country is confronted with a number of EWEs. The current study examines how different types of extreme weather events affect vulnerable people's decisions to have children or to prefer children of a certain gender. People who reside in a particular area may be more vulnerable to particular EWE types, which may result in different preferences for fertility and gender. This study employed individual-level data from three places (flood-prone, drought-prone, and cyclone-prone), each exposed to a distinct hazard, to address this issue, and collected pertinent information from 177 respondents in the susceptible areas using a survey questionnaire. The quantitative results show that the gender of the first child, the perceived risk of infant death due to EWE, the opinion on having more children to recover from the damage and losses caused by EWE, government and non-governmental organization (NGO) support during EWE, and the intended timing of child bearing (after or before EWE) are all significant factors influencing fertility preferences and gender preferences. The findings also indicate that the three regions under investigation have statistically distinct preferences for fertility and gender. There were larger differences between flood-prone areas and drought- and cyclone-prone areas. The complex issue of variations due to different EWEs requires more in-depth studies with larger samples and different methodological techniques.

KEYWORDS

Bangladesh, extreme weather events, fertility preference, gender preference, intended fertility timing, perceived risk of dying

1 Introduction

Extreme weather events associated with climate change are very common in Bangladesh (floods, cyclones, and droughts) and can affect the socioeconomic conditions and livelihoods of people in climate-sensitive areas in the country (Rahman and Rahman, 2015). Irregular and unexpected changes in climate parameters such as rainfall patterns and temperature fluctuations gradually enhance the intensity of EWEs (Thakur et al., 2012). The increased risk of EWEs affects population dynamics, namely, fertility dynamics. Exploring the complex relationships between extreme weather events and fertility dynamics is difficult due to a lack of detailed studies in the context of developing countries. However, the impact of EWEs can be an important determinant of several aspects such as fertility preferences and gender preferences. Several studies such as Adhikari (2010) in Nepal and Nahar and Van der Geest (2015) in Bangladesh have examined socio-economic and cultural aspects while studying fertility trends and differentials. Adhikari (2010) found that perceived ideal number of children, age at first marriage, level of education, experiences with infant mortality, and wealth status have a strong influence on fertility. Nahar and Van der Geest (2015) also found that patriarchal society influences women to have children and stigmatizes those who are childless.

Fertility rates may change as parents desire more children, especially sons, to compensate for loss and damage during EWEs (Preston, 1978; Hossain et al., 2007), viewing these children as insurance against future risks, whether risk sharing at the household or community level (Cain, 1981; Cain, 1983; Cain, 1986; Frankenberg et al., 2014). Although there are opposite arguments, fertility may increase following disasters and related stresses (Norris et al., 2002; Finlay, 2009; Nobles et al., 2015; Nandi et al., 2018). Disaster-induced shocks can also lead to lower fertility (Portner, 2001) because women are less interested in having children (Norris et al., 2002; Frankenberg et al., 2014). In addition, high infant mortality (Lutz et al., 2006; Neumayer, 2006; Sandberg, 2006) and perceived risk of infant mortality (Haq and Ahmed, 2019) are associated with the number of children that parents want to have a surviving child. The experience of loss and injury from EWEs, as well as recovery from the negative effects of EWEs (Haq, 2018), and the experience of family members or other community leaders with EWEs contribute to the perception of the possibility of losing one or more children in the future (Norris et al., 2002; Neria et al., 2008). As a result, this perception influences couples to favor having more children and to view children of a particular sex as safe and future protection.

For Bangladesh, in 2014, the total fertility rate was above replacement level in five out of seven regions: Sylhet (TFR 2.9), Chittagong (TFR 2.5), Dhaka (TFR 2.3), Barisal (TFR 2.2) and Rajshahi (TFR 2.1). Other divisions have fertility rates slightly below replacement level, such as Khulna (TFR 1.9) and Rangpur (TFR 1.9) (NIPORT et al., 2016). As with total fertility, there is spatial variation in child mortality in Bangladesh, with Sylhet having the highest child mortality rate (67 deaths per 1,000 live births) among other divisions (Gruebner et al., 2017). In addition, Sylhet is more prone to floods (Alamgir et al., 2020), Rajshahi and Rangpur to droughts (Hasan et al., 2016), and Chittagong, Khulna and Barisal to cyclones (Alam and Rahman, 2014; Islam and Walkerden, 2015; Haque and Jahan, 2016). Bangladesh is highly vulnerable to flooding and increasingly faces extreme weather events, particularly floods (Ahmed et al., 2019). Haq (2019), using data from the Flood Forecasting and Warning Centre (FFWC) and the Bangladesh Planning Commission for the three decades of the 1980s, 1990s, and 2000s, found that the country has experienced a higher number of floods (28) compared to cyclones (18) and droughts (7), respectively. In a recent study of climate events and migration decisions for the following countries: Cambodia, Nicaragua, Peru, Uganda and Vietnam, Koubi et al. (2022) mentioned that there may be variations in people's migration patterns from one climate change to another, and that the decision to migrate may even be different with the same type of climate change. They also argued that migration decisions and patterns also depend on a range of interactions between climatic events and individual or household characteristics (e.g., education, religion, household head, income level, gender and age). In this case, this study is a novelty to examine the relationship between experience with EWE types and fertility dynamics considering Bangladesh as a case. However, there are no studies showing the difference in fertility preference and gender preference with respect to the types of extreme weather events that people in vulnerable areas experience with their negative impacts.

Aforementioned studies in different locations suggest that EWEs can lead to adaptation of vulnerable populations through a variety of measures, including changes in choices to prefer children and children of a particular sex. Fertility preference and gender preference may change depending on the vulnerable populations' experiences with the different impacts from the different types of EWEs (e.g., floods, cyclones, and droughts). Fertility preferences are defined as plans to have or not to have children in the face of the current circumstances and desired number of children (Bongaarts, 2001; Sasson and Weinreb, 2017). For instance, people's experiences with different types of EWEs might cause different choices either increasing the desired number of children or decreasing the desire to have more children and to prefer for children of particular sex (Lechowska, 2018). Experiences with different types of shocks, including EWEs, might primarily prompt vulnerable people to reconsider how to cope with the uncertainty of future adverse effects from climate change-related extreme events and to choose fertility adjustment from different options such as changes in preferred number of children, preferred sex for future children, and timing of child bearing (after or before shocks) (Miller and Pasta, 1995).

The above studies led to the two research questions of this study: first, how do experiences with different types of EWEs influence different choices to have children and second, do they affect to prefer children of one sex? This study aims to compare how the experience with the effects of different EWEs influence on both types of preferences in these climate-sensitive areas of Bangladesh. The questions led to the hypothesis that those who experience EWEs and feel they need more help to recover quickly from the devastation and loss tend to have more children and prefer male children. Second, there might have variations regarding fertility preference and gender preference between the different types of extreme weather event prone areas considered in the study. People living in flood-prone areas may have different choices to prefer children and particular sex (male) for the future children than people living in drought- or cyclone-prone areas.

The rest of the paper includes relevant research on extreme climate events and fertility dynamics (Section 2), and provides details and justification for the hypotheses considered in this study. To answer the research questions of the study, three different areas of Bangladesh that are vulnerable to extreme climate events were investigated to gather relevant information. Details on the selection of study areas, data collection, and data analysis techniques are discussed in Section 3. Based on several advanced statistical analyses, the following Section 4 presents the results and their interpretation, and Section 5 provides a final discussion with the main results of the study and comparison with other studies and suggestions for future research.

2 Literature review

The relationship between climate change and human fertility and reproductive health is a pressing issue (Grace, 2017). However, studying the relationship between the environment and preferred family size and family planning practices is complex (Ghimire and Mohai, 2005; Haq, 2013). For example, changes in fertility may result from the extent of the impact of EWEs and adverse environmental conditions (Ellis, 2000; Sherbinin et al., 2008). In Ethiopia, for example, conception rates declined during the drought and famine of 1970–1980 (Lindstrom and Berhanu, 1999). The historic 1958–61 famine in China had a similar effect on fertility (Coale, 1981; Ashton et al., 1984). Razzaque (1988) showed that as a result of the 1974 famine, fertility rates in Bangladesh were low among low-income household heads because they had moved to nearby cities in search of work, and their absence affected the frequency of sexual intercourse. Thus, fertility increases or decreases after natural disasters, as it is influenced by the timing of pregnancies and fertility preferences of couples (Tong et al., 2011). Dasgupta (2000) and Sasson and Weinreb (2017) argue that people find it beneficial to have more children during environmental disasters. Factors such as infant mortality, land loss, and changes in socioeconomic status due to environmental disasters may promote or reduce the preference to have more children (Haq, 2013). Having more children, especially more boys, is seen as beneficial in the face of environmental stress and extreme weather events (de Sherbinin et al., 2008; Haq, 2018). In addition, high fertility also becomes a strategy to meet the demand for agricultural labor (Lutz and Scherbov, 2000).

Other studies, such as that by Aggarwal et al. (2001) in South Africa, show a positive correlation between the effects of firewood and water scarcity on fertility preferences, while Biddlecom et al. (2005) in Nepal, show a negative correlation between the two factors (water scarcity and fertility preferences). In Nepal, those who believed that current forest resources, water levels, and agricultural productivity decreased in the last 3 years were more likely to use contraceptives than those who believed that these three variables had remained the same or increased. Their perception that it would be difficult for them to bear the burden of large families if they had more children because of declining forest resources, water levels, and land productivity led them to use contraception to control future births (Ghimire and Mohai, 2005). In Angola, voluntary birth control influences people's propensity to reduce fertility after crisis such as war because of horrific experiences and concerns about the possibility of another crisis (Agadjanian and Prata, 2001).

According to Jones (1981), Asian countries are very often faced with natural disasters and this influences having a population surplus as demographic insurance against the effects of disasters, leading to an increase in fertility in Asia compared to Europe. Similarly, a study in an African country (Malawi), Yeatman et al. (2013) found that, due to the high risk of climate threats (e.g., extreme heat and flooding); people are more likely to have more children (Yeatman et al., 2013). Parents give birth to more children than they ultimately hope to because they expect some will not survive (Preston, 1978; Cain, 1981; Pörtner, 2008). In Indonesia, Nobles et al. (2015) found that women who lost one or more children in the 2004 tsunami were more likely to desire more children. A greater desire to have at least some surviving children is considered as an insurance mechanism (Cain, 1981; Finlay, 2009). Indeed, during crises, children are at greater risk and have fewer resources to protect themselves (Hogan and Marandola, 2012).

Lin (2010) examines how natural disasters affect fertility in Italy (earthquakes) and Japan (tsunami), based on the argument that differences in fertility are due to differences in the prevalence of natural disasters rather than differences in culture, society, etc. Lin (2010) found that disasters have a significant effect on fertility, especially the decline in marital fertility for both Italy and Japan, and that this is due to environmental shocks that cause people to be less willing to have more children. Moreover, the degree of association between disaster and fertility was found to vary according to the type of disaster (Lin, 2010). The study also found that disaster-related mortality is not only a factor affecting fertility, but other reasons (e.g., economic volatility due to environmental shocks) also contribute to fertility dynamics. However, studies by Finlay (2009) in India, Pakistan, and Turkey show that high disaster-related mortality (earthquakes) leads to high fertility, as having more children in affected households is considered as an insurance. The positive effect of disasters on fertility was also consistent with a recent study on the effect of the 2001 earthquake in India by Nandi et al. (2018).

Bangladesh, one of the most populous countries, is a low-lying South Asian country. In recent years, fertility in the country has fallen by half-compared to the 1980s and 1990s, making it a success story of dramatic fertility decline approaching replacement level. In Bangladesh, different factors such as experiences and perceptions related to EWE, especially flooding, such as having sons as helpers to cope with EWE and repaying borrowed money during EWE, and cultural perceptions and beliefs such as frequent EWE due to increased sinful activities and having sons as a gift from God influence fertility preferences (Haq, 2018).

Previous fertility studies have examined the perceived costs and benefits to couples of having children that influence higher childbearing and a particular gender preference as an adjustment to financial insufficiency and future social security and protection in old age, such as Cain's (1981) study in Bangladesh. However, very few studies examine the link between people's experience with the impacts of different types of EWE and fertility dynamics, such as preference for additional children and gender preference for future children. Therefore, the study investigates whether there are variations between different types of EWE-prone areas (e.g., flood-, drought-, and cyclone-prone areas) in terms of the choice to prefer additional children and children of a particular gender.

The literature cited above shows mixed results and several factors or mechanisms that accelerate or reduce fertility preferences and gender preferences following natural disasters. Based on this, this study used fertility preference and gender preference as dependent variables. The independent variables include: type of the EWE, religion, gender of the first child, gender of the sole child, perceived risk of dying from EWE, impacts of EWEs influencing gender preference, intended timing of child bearing (before or after EWE), need for more children for recovering from EWE, support from governmental and NGOs to reduce preference for future children, and ever use of contraception, years of schooling, age at first birth, and age of first child.

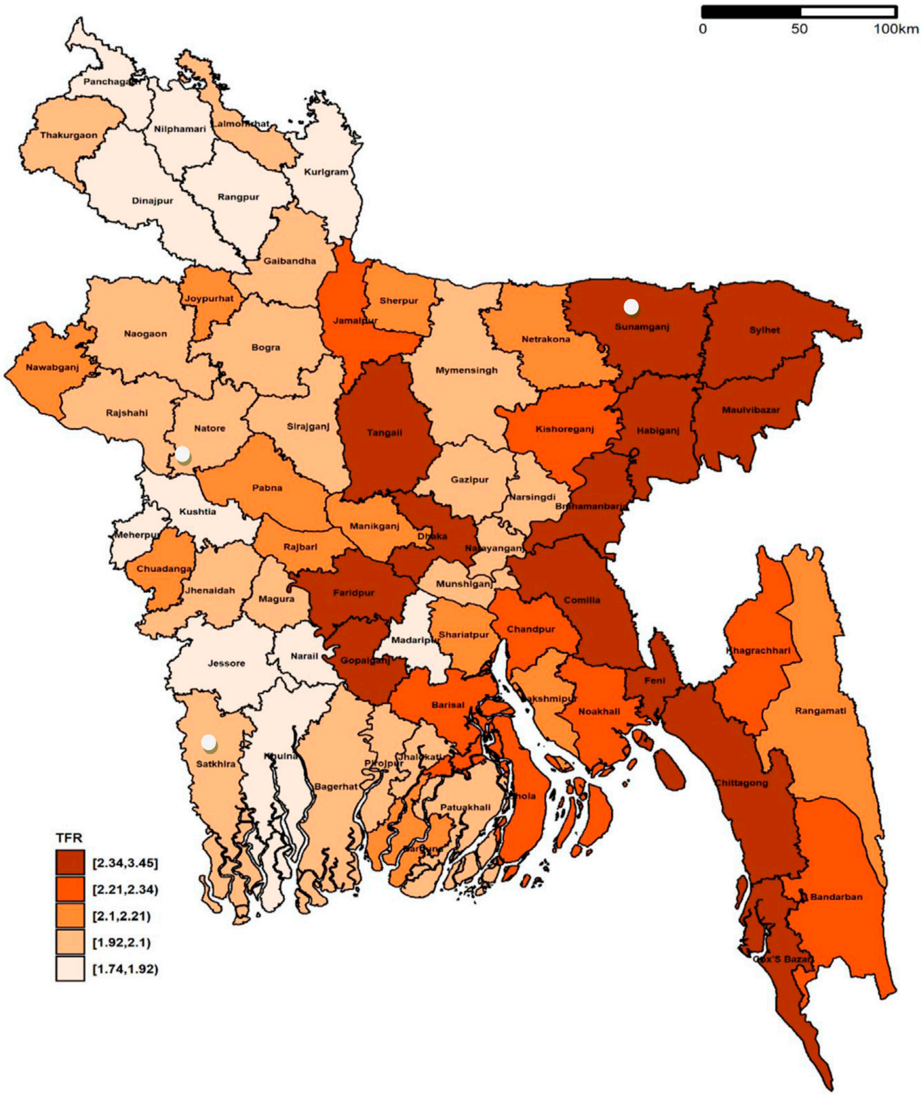

FIGURE 1
Spatial variations of TFR across administrative districts of Bangladesh. Source: Saha et al. (2023), https://doi.org/10.1007/s40980-022-00113-1.

3 Methodology

3.1 Study location and population

This study aims to see whether the perceptions and opinions on EWEs could be related to Bangladesh fertility decline by looking at the variations in the effect of different EWEs on fertility. Tahirpur Upazila (Singulate mean age at marriage: men = 26.48 years, women = 20.64 years) in Sunamganj district (TFR = 3.64) of Sylhet Division, Lalpur Upazila (Singulate mean age at marriage: men = 24 years, women = 18.48 years) in Natore district (TFR = 1.84) of Rajshahi Division and Shyamnagar Upazila (Singulate mean age at marriage: men = 24.52 years, women = 18.54 years) in Satkhira district (TFR = 1.79) of Khulna Division (BBS, 2011; NIPORT et al., 2019), were selected for the study as flood, drought and cyclone-prone respectively. Figure 1 shows the spatial variations of TFR in Bangladesh and Figure 2 shows the study sites. A recent study by Saha et al. (2023) on estimating the total fertility rate in small areas in the country shows that Sunamganj has the highest fertility rate (TFR: 2.34-3.45) compared to other selected districts, such as Natore and Satkhira, which have close to replacement level (TFR: 1.92-2.1).

Tahirpur has a literacy rate of 33.4%, a sex ratio of 105, a proportion of married men of 58.9% and of married women of 62.0% of the population aged of at least 10 years, and an average household size of 5.59. In the upazila, the total population with aged 20–24 is 15,909 and with aged 30–34 is 13,422. 56.09% of people, aged 20–24 are women and the sex ratio is 78. On the other hand, in the 30–34 age group, 49.99% are men and the sex ratio is 100 (BBS, 2011).

In Lalpur, the literacy rate is 50.6%, the sex ratio is 102, married men and married women represent 66.4% and 70.3% respectively (10 years and older), and the average household size is 4.13. In the

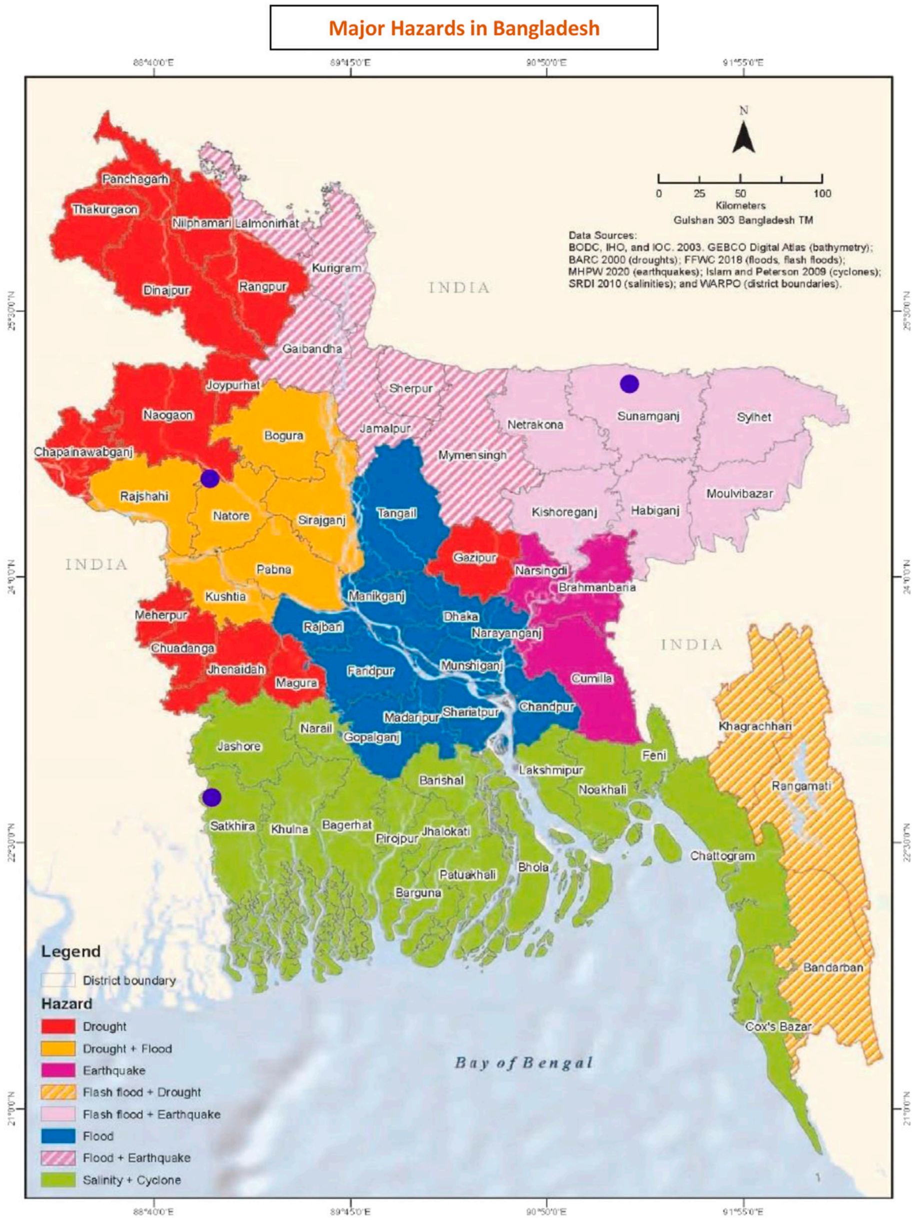

FIGURE 2
Areas vulnerable to different types of EWE and study locations (Bangladesh). Source: Asian Development Bank (2021), https://www.adb.org/sites/default/files/publication/760781/bangladesh-climate-disaster-risk-atlas-volume2-cover-pgxxiv.pdf.

upazila, the total population with aged 20–24 is 25,066 and with aged 30–34 is 21,941. 57.36% of people, aged 20–24 are women and the sex ratio is 74. On the other hand, in the 30–34 age group, 48.6% are men and the sex ratio is 95 (BBS, 2011).

In Shyamnagar, the literacy rate is 48.6%, the sex ratio is 93, the proportion of married men and married women are 64% and 67.2% respectively (10 years and older), and the average household size is 4.39. In the upazila, the total population with aged 20–24 is 28,569 and with aged 30–34 is 23,866. 61.34% of people, aged 20–24 are women and the sex ratio is 63. On the other hand, in the 30–34 age group, 45.71% are men and the sex ratio is 84 (BBS, 2011).

The Bangladesh Demographic Health Survey (BDHS) in 2011 shows that the TFR in flooding zone is almost twice as high as in the other two areas drought-prone (close to the replacement level) and cyclone-prone (below the replacement level), while the national average of fertility rate in 2017 was 2.3 (NIPORT and ICF, 2019). BDHS reports for 2011, 2014 and 2017–2018 indicate the TFR for Sylhet (3.1, 2.9 and 2.6 respectively), Rajshahi (TFR = 2.1, for all the survey years) and Khulna (calendar year TFR = 1.9, for all the survey years) (NIPORT and ICF, 2019). The TFR in drought- and cyclone-prone areas has not changed in the past few years. However, the TFR in Sylhet is declining and is higher than in the other regions.

3.2 Sampling and data collection

In order to determine if fertility preferences and gender preferences change in terms of the sorts of extreme weather events, the current study chose the three susceptible locations that are known for the three distinct extreme weather events. It takes into account different places that are sensitive to various EWEs as a categorical variable in an effort to determine the likelihood for various areas by taking into account a specific region that is vulnerable to a certain type of EWE as a reference category based on survey data collected in the three chosen locations. In addition, the nation frequently experiences catastrophic flooding, which in 1998 encompassed 68% of the nation's land area. More recently, flooding has hit the next-largest (42%) in 2007 and the third-largest (38%) in 2004 respectively (Bangladesh Water Development Board, 2007; Islam and Mechler, 2007).

In a study by Dastagir (2015), a GIS map was modified to model recent extreme flood events caused by climate change and to identify flood-prone areas in terms of types of flooding: riverine floods, flash floods, and tidal floods. Each type of flooding was classified as severe, moderate, and minor flooding with the aim of determining the flood risk for Bangladesh until 2050. The flood levels, flood extent, and extreme flood duration were generated for this purpose using the digital elevation model, yearly hydrological function, and national flood model of Bangladesh. The simulation also included data from more than 200 rainfall stations and about 30 evapotranspiration stations, as well as the major rivers and canals of the nation (Khals) (10,235 km), existing flood control and drainage infrastructure, and flood control measures, floodplains (1,147 km), and connecting canals. However, because the study was based on a survey and did not take into account granular data, GPS coordinates, which could be used to compare the results of future studies with those of the present study, the types of EWEs and the severity of each type were not taken into account in the present study.

Our study included married men aged 30–34 years and women aged 20–24 years because they have a wide fertility range. The study plans to include married men and women who have at leastone child. The reason for including men in the study between the ages of 30 and 34 is that, according to the NIPORT, Mitra and Associates, and ICF International (2015), nearly 50% of men in this age range want to have more children. Because the average age difference between spouses is about 9 years, the study also includes women between the ages of 20 and 24 (about 50% of them also want more children). A questionnaire survey (see Appendix A) was conducted and collected relevant information from 177 respondents from three areas prone to EWEs. The survey interviewed either the husband or the wife, so that a respondent could freely express his or her opinion without being influenced by his or her spouse. Only data from men and women of the above ages who had at least one child during the fieldwork period were considered in order to select fecund couples. Respondents without children were excluded from the survey because they were likely to be newly married men and women who experienced fewer effects of EWEs after their marriage. Therefore, the study set the standard age at 20–24 years for women and 30–34 years for men with at least one child. The aim of the study was to determine whether the greater willingness of men and women with at least one child to have more children is associated with the effect of EWE, and whether the gender preference of future children depends on whether the first child is a boy or a girl. Examining the relationship between the effects of extreme weather events and fertility preferences in these age groups can contribute to a better understanding of future fertility dynamics.

In addition, the study did not include income level, access to insurance or other financial support as factors that influence to reduce the effect of EWEs, and then fertility preference. Since we collected data from married people in a specific age group of 20–24 (women), 30–34 (men), since the head of household is usually a man, senior person, the respondent sometimes lives in a joint family, and the head of the family knows the income of the family, it is difficult to obtain information on income level. In 2017, only 14.2% of households in Bangladesh were headed by women (Bangladesh Sample Vital Statistics 2011–2017, BBS). No such insurance against climate change exists in Bangladesh. The study assumes that people living in vulnerable areas may consider having more children and more sons as a future insurance during a crisis. The study included whether respondents consider government support and support from NGOs to reduce the preference for more children in the future or not. However, the study did not ask respondents what kind of support, whether the support is sufficient, whether support is in the form of credit from NGOs, whether it is credit with interest and increasing repayment burden, since EWEs are particularly flood frequent, and consequently affect their fertility decision and flood protection measures, may be a future research.

Before the interviews, we clearly explained the purpose of the study and assured respondents that we would treat the information they provided confidentially and anonymously. After obtaining their consent, we began to collect relevant information from respondents in the three selected areas. There were two field teams to collect data from each of the regions, and each team consisted of two interviewers (one male and one female) who knew the dialect of the region. The author coordinated the operations throughout. The field teams met with elected members of the Union Parishad (UP: the smallest and lowest level of local government) to receive detailed information on which villages were most affected by specific extreme events and how to reach targeted respondents. Their instructions facilitated our data collection for the selected villages in the three upazilas.

3.2.1 Flood-prone area

To gather relevant information, interviewers visited each household to find out how many married men (aged 30–34) and women (aged 20–24) with at least one child lived there and noted their names and contact numbers from the selected two villages (Chiksa and Jamalgar). If we did not find a respondent in a household who met the above criteria, we moved on to the next household. Married men were usually available in the evenings, and we contacted them by phone to arrange interviews. In the end, we collected information from 80 respondents. In both villages, there were fewer men than women during the day because they worked as day laborers outside their own village.

3.2.2 Drought-prone area

The same interviewers found 100 residents meeting the age criteria: men aged 30–34 and women aged 20–24. The challenge in Gouripur village was that few married men aged 30–34 were available to be interviewed because they worked as laborers during the day. We tried to interview them in the evening, but

TABLE 1 Collinearity statistics.

Independent variables	Dependent variable			
	Fertility preference		Gender preference	
	Tolerance	VIF	Tolerance	VIF
Type of EWEs people are experienced with (Flood-prone = 1, Drought-prone = 2; Cyclone-prone = 3)	0.634	1.578	0.593	1.687
Gender of interviewee (Male = 1; Female = 0)	0.281	3.560	0.290	3.446
Religion (Islam = 1; Others = 0)	0.860	1.162	0.724	1.381
Having at least one son (Yes = 1; No = 0)	0.770	1.299	0.710	1.408
Gender of first child is male (Yes = 1; No = 0)	0.806	1.240	0.727	1.376
Perceived risk of dying due to EWEs (Yes = 1; No = 0)	0.795	1.258	0.810	1.235
Intended time for child bearing (Before EWEs = 1; After EWEs = 0)	0.864	1.157	0.836	1.196
Preference for children to recover from EWEs impacts in future (Yes = 1; No = 0)	0.725	1.380	0.750	1.333
Govt. and NGOs support to lower preferences for more children in future (Yes = 1; No = 0)	0.733	1.365	0.689	1.451
Ever use of contraceptive (Yes = 1; No = 0)	0.861	1.161	0.819	1.221
Years of schooling	0.813	1.230	0.747	1.339
Age at first birth (years)	0.322	3.107	0.358	2.790
Age of first child (months)	0.483	2.071	0.616	1.623

they were too tired to be interviewed. Therefore, we included more married women. During the field study in March 2018, it was very hot and because of the heat, the respondents seemed agitated and did not want to be interviewed. The sample is made of 35 respondents from the two villages of Palideha and Gouripur.

3.2.3 Cyclone-prone area

Following a similar strategy as in the flood and drought areas, the same interviewers also collected information from 62 respondents in the villages of Gabura and Khalishabunia, out of 112 residents (men between 30 and 34 years old and women between 20 and 24 years old). The residents mentioned Gabura as the worst affected area by Cyclone Aila in 2009 and eagerly described their suffering to convince us to provide support and asked us to include their names in the relief lists as they were considering us as being from donor organizations. Still, it was very difficult to talk to them about anything other than the cyclone. The villagers were reluctant to talk to us. They said that they had talked to many people about their suffering but had not received any support from them.

3.3 Methods of data analysis

Our study uses descriptive statistics to summarize all the variables of the study and inferential statistics to analyze the quantitative data by using SPSS software (version 23), which are explained below.

The present study compares the means of the dependent and independent variables (listed in Section 2) with variance analyses to see whether there are any differences among the three selected vulnerable areas. Before performing General linear models (GLM), this study checked for multicollinearity, whether there is a high correlation between dependent variables and independent variables. From the analysis, this study found that there is no independent variable, which is highly correlated with the both independent variables. Table 1 shows that none of the variance inflation factor (VIF) values for the predictor variables is greater than 5, which indicates that multicollinearity will not be a problem to perform regression analysis, e.g., GLM analysis in the present study (Akinwande et al., 2015; Ahinkorah et al., 2021).

General linear models (GLM) are performed to see how the predictor variables shown in Tables 2, 3 influence fertility and gender preferences. The outcome variables such as preference for additional children (Yes or No) and gender preference for future children, particularly male children (Yes or No) are measured on a binary scale (Miller and Pasta, 1995). Education level, age at first birth, and age of first child were also included as covariates in the GLM. Table 1 shows that the sample sizes for the three areas studied (flood-prone = 80; drought-prone = 35; and cyclone-prone = 62) are not equal. Levene's test for equality of variance (Saffa et al., 2019) used to see whether the variances of the two dependent variables for the three areas are approximately equal or not at $p < .05$. The p-value from Levene's test was greater than 0.05, meaning that the variances of the variables for the three areas are equal, which suggests to perform GLM.

4 Results

4.1 Samples' description

The results shown in Table 2 reveal that in terms of socio-demographic characteristics, about half of the respondents in these

TABLE 2 Descriptive statistics: Analysis of variance tests.

Variables	Variables	EWEs-prone areas	N	Mean	Std. Deviation	95% confidence interval for mean		Sig
						Lower bound	Upper bound	
Dependent variables	Preference for additional children (Yes = 1)	Flood	80	0.65	0.480	0.54	0.76	0.015
		Drought	35	0.63	0.490	0.46	0.80	
		Cyclone	62	0.42	0.497	0.29	0.55	
		Total	177	0.56	0.497	0.49	0.64	
	Gender preference for future children (Yes = 1)	Flood	80	0.84	0.371	0.75	0.92	0.657
		Drought	35	0.86	0.355	0.74	0.98	
		Cyclone	62	0.79	0.410	0.69	0.89	
		Total	177	0.82	0.381	0.77	0.88	
Independent variables	Gender of interviewee (Male = 1)	Flood	80	0.44	0.499	0.33	0.55	0.259
		Drought	35	0.43	0.502	0.26	0.60	
		Cyclone	62	0.56	0.500	0.44	0.69	
		Total	177	0.48	0.501	0.41	0.55	
	Religion (Islam = 1)	Flood	80	0.75	0.436	0.65	0.85	0.002
		Drought	35	0.91	.284	0.82	1.01	
		Cyclone	62	0.95	0.216	0.90	1.01	
		Total	177	0.85	0.355	0.80	0.91	
	Having at least one son (Yes = 1)	Flood	80	0.59	0.495	0.48	0.70	0.698
		Drought	35	0.66	0.482	0.49	0.82	
		Cyclone	62	0.65	0.482	0.52	0.77	
		Total	177	0.62	0.486	0.55	0.69	
	Gender of first child is male (Yes = 1)	Flood	80	0.42	0.497	0.31	0.54	0.667
		Drought	35	0.51	0.507	0.34	0.69	
		Cyclone	62	0.47	0.503	0.34	0.60	
		Total	177	0.46	0.500	0.38	0.53	
	Perceived risk of dying due to EWEs (Yes = 1)	Flood	80	0.92	0.265	0.87	0.98	0.000
		Drought	35	0.63	0.490	0.46	0.80	
		Cyclone	62	0.69	0.465	0.58	0.81	
		Total	177	0.79	0.412	0.72	0.85	
	Intended time for child bearing (Before EWEs = 1)	Flood	80	0.39	0.490	0.28	0.50	0.000
		Drought	35	0.29	0.458	0.13	0.44	
		Cyclone	62	0.10	0.298	0.02	0.17	
		Total	177	0.27	0.443	0.20	0.33	
	Preference for children to recover from EWEs impacts in future (Yes = 1)	Flood	80	0.82	0.382	0.74	0.91	0.000
		Drought	35	0.57	0.502	0.40	0.74	
		Cyclone	62	0.52	0.504	0.39	0.64	
		Total	177	0.67	0.473	0.60	0.74	

(Continued on following page)

TABLE 2 (*Continued*) Descriptive statistics: Analysis of variance tests.

Variables	Variables	EWEs-prone areas	N	Mean	Std. Deviation	95% confidence interval for mean		Sig
						Lower bound	Upper bound	
	Govt. and NGOs support to lower preferences for more children in future (Yes = 1)	Flood	80	0.76	0.428	0.67	0.86	0.000
		Drought	35	0.31	0.471	0.15	0.48	
		Cyclone	62	0.52	0.504	0.39	0.64	
		Total	177	0.59	0.494	0.51	0.66	
	Ever use of contraceptive (Yes = 1)	Flood	80	0.44	0.499	0.33	0.55	0.003
		Drought	35	0.71	0.458	0.56	0.87	
		Cyclone	62	0.68	0.471	0.56	0.80	
		Total	177	0.58	0.496	0.50	0.65	
	Years of schooling	Flood	80	3.29	3.346	2.54	4.03	0.000
		Drought	35	7.23	5.117	5.47	8.99	
		Cyclone	62	6.40	4.166	5.35	7.46	
		Total	177	5.16	4.369	4.51	5.81	
	Age at first birth (years)	Flood	80	21.95	4.115	21.03	22.87	0.598
		Drought	35	21.17	4.579	19.60	22.74	
		Cyclone	62	21.71	5.052	20.02	22.59	
		Total	177	21.57	4.541	20.90	22.24	
	Age of first child (months)	Flood	80	50.69	32.430	43.47	57.90	0.005
		Drought	35	66.97	53.720	48.52	85.42	
		Cyclone	62	73.00	42.771	62.14	83.86	
		Total	177	61.72	42.062	55.48	67.96	

three areas are male, with a slightly higher percentage in the cyclone area. In all three areas, the majority of respondents are Muslim.

The mean scores for the wish of having more children in the future and gender preference for future children are relatively higher in flood-prone areas (0.65 and 0.84) and in drought-prone (0.63 and 0.86) than in cyclone-prone areas (0.42 and 0.79). The preference for more children is statistically significant different between the three areas ($p < 0.05$); people in flood- and drought-prone areas have a relatively higher preference for having more children than those in cyclone-prone area. However, gender preference is not statistically significant but is more prevalent among the three areas than the preference for having more children. People's preference for additional children is much lower in the cyclone-prone area than in other areas, but people in all three areas have a higher gender preference.

Regarding the variables of having at least one son and whether the gender of the first child is male and the influence of the EWEs on gender preference, the analysis of variance shows no statistically significant difference between the type of EWE ($p > 0.05$). In addition, schooling is almost twice as high in drought- and cyclone-prone areas as in flood-prone areas (3.29 years). This means that many of the people living in flood-prone areas have low levels of education. For the age of the first child (months), the analysis of variance shows a statistically significant difference between the type of EWE ($p < 0.05$). The age of the first child is relatively higher in cyclone prone areas than in the other two areas. Moreover, the mean difference between flood-prone and cyclone-prone areas is much larger than the difference between drought-prone and cyclone-prone areas.

The mean score for the perceived risk of death from EWE is much higher in flood-prone areas (0.92) than in drought-prone (0.63) or cyclone-prone areas (0.69). This suggests that the risk of child death is perceived to be higher in flood-prone areas than other areas; it may be because of their experience of children dying from drowning in floods that makes them prefer more children. In all three areas, most people would consider having more children being recovering quickly from the negative effects of EWE when they were asked whether they need help to recover from the harm caused by EWE. People in flood-prone area (mean = 0.82) are significantly more likely to consider that they need help to recover from the effects of EWE in comparison to the other areas (mean = 0.60). In addition, residents in the flood zone felt that they would prefer to have fewer children than in the other zones if they could get enough support from the government and NGOs (mean = 0.76; 0.57 in drought-prone areas and 0.52 in cyclone-prone areas) to recover from the flood. However, less than one-third of the respondents in the drought areas (mean = 0.31) felt that support from the government or NGOs would reduce their preference for having more children. That means that most of the people in drought-prone area feel that adequate support would not reduce their preference for fertility.

The study also asked respondents when they would like to have children - before or after EWE. The results show that people consider having children after EWE. The mean for choosing when to have children in the three areas was 0.27 (where 1 means before EWE and 0 means after EWE). However, the higher mean in the flood-prone area means that some people in that area also tend to prefer to have children before an EWE. The decision to have a child after an EWE may be related to the risk of a recent climatic event, or to uncertainty about whether the child can be placed in a safe location.

In terms of ever use of contraception, the mean score in flood-prone areas was .44 and around .70 in the other two areas, suggesting that people in flood-prone areas are less likely to use contraceptives than people in other areas. This may be because their area is affected by floods and contraceptives are less available and accessible or because they want more children. It may also be because schooling in the area is very low and awareness or interest in contraceptive use may be low as well.

The study also performed a Tukey HSD analysis using the Tukey test (Table 3), which provides more insight into whether there are statistically significant differences between the three climate risk areas of Bangladesh in terms of the variables included in the study. In the study, the *post hoc* Tukey test compares the mean of one susceptibility area to climate change with the mean of the other susceptibility area. This test is usually used when sample sizes are unequal between groups. For instance, sample size for the drought prone area was almost half of the sample size of the flood-prone area in the study.

In terms of preference for additional children, the results show that there is statistically significant differences between flood-prone and cyclone-prone areas. In terms of perceived risk of dying due to EWE, people in flood-prone areas viewed the issue differently from other areas, with p-values of less than 0.05 for flood-prone areas than for cyclone-prone areas. However, p-values for Tukey HSD were greater than 0.05 between drought-prone and cyclone-prone areas.

The study also includes information on whether people consider having children before or after EWEs. Based on the Tukey HSD, the study found statistically significant differences between flood-prone and cyclone-prone areas. That is, whether people living in vulnerable areas considered to having children before or after EWEs was different between flood-prone and cyclone-prone areas. For other flood-prone, cyclone-prone, and drought-prone areas, p-values were greater than 0.05. Interestingly, regarding whether people in the three susceptible areas consider having more children to compensate for losses caused by EWEs, the test results showed that people in flood-prone areas think differently than those in other EWE-prone areas ($p < 0.05$). This study also shows similar results about whether government and NGOs support during EWEs reduces the preference for having more children in flood-prone areas than in other climate event-prone areas. Because p-values are higher than 0.05 for both drought-prone and cyclone-prone areas, peoples' perception in the both areas on having more children for rapid recovery after EWEs may be similar. On the question of contraceptive use, there were also significant differences between flood-prone and cyclone-prone areas, and between flood-prone and drought-prone areas. Peoples' perception in the both drought-prone and cyclone-prone areas may similar or close on this point ($p < 0.05$).

There were significant differences between flood-prone areas and other areas in terms of years of schooling. However, the results show that there are no differences in the variable between drought-prone and cyclone-prone areas. This implies that the characteristics of drought- and cyclone-prone areas are more similar to those of flood-prone areas. There were significant differences between flood-prone and cyclone-prone areas in terms of age of first child (months), but no differences between flood-prone and drought-prone areas and between drought-prone and cyclone-prone areas.

Summing up, peoples' perception in the three areas with experience with the different type of EWE (flood, drought, and cyclone) significantly differ regarding their preference for additional children, but not for their gender preference for additional children. Respondents living in flood-prone areas are significantly more likely to perceive a risk of dying due to EWEs, to prefer more children to recover from the EWEs in the future, and to think that this preference would be lower if the Government and NGOs support would be higher.

4.2 EWEs and fertility preference: associated factors

The GLM analysis (shown in Table 4) indicates that the outcome variable "preference for additional children" is statistically significant in the corrected model at $p < 0.01$ with a partial eta squared of .509. Parameter estimates make it possible to understand how each dummy variable affects the outcome variable and whether it is statistically significant. For the dependent variable, the results show that the types of EWE-prone area has a positive effect at the 0.05 level of significance. Indeed, people in the drought-prone area are more likely to prefer additional children ($\beta = 0.23$) compared to the respondents in the cyclone-prone area. However, the same comparison with the flood-prone area is not statistically significant.

If the gender of the first child is male, then it has a significant and negative effect on further fertility preference. Moreover, the perceived risk of children's death from EWE negatively and significantly affects the preference for additional child (ren) in future. This denotes that those who perceive that there is a risk of children's death from EWEs are less likely to prefer more children in the future. It may be due to the experience with frequent extreme weather events and the few that the effects of the events are becoming severe; therefore, they do not to prefer additional children for an increased risk of death in the future. Intended time of child bearing (before or after EWE) and ever use of contraception do not affect the preference for more children. Moreover, the age of the first child slightly contributes negatively to the preference for additional children.

Regarding the influence of religious belief on additional children preference, non-Muslims prefer to have more children than Muslims ($\beta = .230$, $p < .05$). Results also show that those who do not have at least one son are more likely to prefer additional children than those who have at least one son ($\beta = .279$, $p < .05$). But those whose first child is a girl, prefer not to have additional children as compared to those with a first son: if the first child is a daughter, it negatively contributes to change the dependent variable by a .249 unit.

TABLE 3 Multiple comparisons (Tukey HSD).

Variables	(I) Name of the area	(J) Name of the area	Mean difference (I-J)	Std. Error	Sig	95% confidence interval	
						Lower bound	Upper bound
Preference for additional children (Yes = 1)	Flood	Drought	0.021	0.099	0.974	−0.21	0.26
		Cyclone	0.231*	0.083	0.016	0.04	0.43
	Drought	Flood	−0.021	0.099	0.974	−0.26	0.21
		Cyclone	0.209	0.103	0.109	−0.03	0.45
	Cyclone	Flood	−0.231*	0.083	0.016	−0.43	−0.04
		Drought	−0.209	0.103	0.109	−0.45	0.03
Gender preference for future children (Yes = 1)	Flood	Drought	−0.020	0.078	0.965	−0.20	0.16
		Cyclone	0.047	0.065	0.747	−0.11	0.20
	Drought	Flood	0.020	0.078	0.965	−0.16	0.20
		Cyclone	0.067	0.081	0.687	−0.12	0.26
	Cyclone	Flood	−0.047	0.065	0.747	−0.20	0.11
		Drought	−.067	0.081	0.687	−0.26	0.12
Gender of interviewee (Male = 1)	Flood	Drought	0.009	0.101	0.996	−0.23	0.25
		Cyclone	−0.127	0.085	0.293	−0.33	0.07
	Drought	Flood	−0.009	0.101	0.996	−0.25	0.23
		Cyclone	−0.136	0.106	0.405	−0.39	0.11
	Cyclone	Flood	0.127	0.085	0.293	−0.07	0.33
		Drought	0.136	0.106	0.405	−0.11	0.39
Religion (Islam = 1)	Flood	Drought	−0.164	0.070	0.051	−0.33	0.00
		Cyclone	−0.202*	0.058	0.002	−0.34	−0.06
	Drought	Flood	0.164	0.070	0.051	0.00	0.33
		Cyclone	−0.037	0.073	0.865	−0.21	0.13
	Cyclone	Flood	0.202*	0.058	0.002	0.06	0.34
		Drought	0.037	0.073	0.865	−0.13	0.21
Having at least one son (Yes = 1)	Flood	Drought	−0.070	0.099	0.761	−0.30	0.16
		Cyclone	−0.058	0.083	0.765	−0.25	0.14
	Drought	Flood	0.070	0.099	0.761	−0.16	0.30
		Cyclone	0.012	0.103	0.993	−0.23	0.26
	Cyclone	Flood	0.058	0.083	0.765	−0.14	0.25
		Drought	−0.012	0.103	0.993	−0.26	0.23
Gender of first child is male (Yes = 1)	Flood	Drought	−0.089	0.102	0.654	−.33	0.15
		Cyclone	−0.043	0.085	0.870	−0.24	0.16
	Drought	Flood	0.089	0.102	0.654	−0.15	0.33
		Cyclone	0.047	0.106	0.899	−0.20	0.30
	Cyclone	Flood	0.043	0.085	0.870	−0.16	0.24
		Drought	−0.047	0.106	0.899	−0.30	0.20

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TABLE 3 (*Continued*) Multiple comparisons (Tukey HSD).

Variables	(I) Name of the area	(J) Name of the area	Mean difference (I-J)	Std. Error	Sig	95% confidence interval	
						Lower bound	Upper bound
Perceived risk of dying due to EWEs (Yes = 1)	Flood	Drought	0.296*	0.080	0.001	0.11	0.48
		Cyclone	0.231*	0.067	0.002	0.07	0.39
	Drought	Flood	−0.296*	0.080	0.001	−0.48	−0.11
		Cyclone	−0.065	0.083	0.715	−0.26	0.13
	Cyclone	Flood	−0.231*	0.067	0.002	−0.39	−0.07
		Drought	0.065	0.083	0.715	−0.13	0.26
Intended time for child bearing (Before EWEs = 1)	Flood	Drought	0.102	0.086	0.467	−0.10	0.31
		Cyclone	0.291*	0.072	0.000	0.12	0.46
	Drought	Flood	−0.102	0.086	0.467	−0.31	0.10
		Cyclone	0.189	0.090	0.093	−0.02	0.40
	Cyclone	Flood	−0.291*	0.072	0.000	−0.46	−0.12
		Drought	−0.189	0.090	0.093	−0.40	0.02
Preference for children to recover from EWEs impacts in future (Yes = 1)	Flood	Drought	0.254*	0.092	0.017	0.04	0.47
		Cyclone	0.309*	0.077	0.000	0.13	0.49
	Drought	Flood	−0.254*	0.092	0.017	−0.47	−0.04
		Cyclone	0.055	0.096	0.832	−0.17	0.28
	Cyclone	Flood	−0.309*	0.077	0.000	−0.49	−0.13
		Drought	−0.055	0.096	0.832	−0.28	0.17
Govt. and NGOs support to lower preferences for more children in future (Yes = 1)	Flood	Drought	0.448*	0.094	0.000	0.23	0.67
		Cyclone	0.246*	0.079	0.006	0.06	0.43
	Drought	Flood	−0.448*	0.094	0.000	−0.67	−0.23
		Cyclone	−0.202	0.098	0.102	−0.43	0.03
	Cyclone	Flood	−0.246*	0.079	0.006	−0.43	−0.06
		Drought	0.202	0.098	0.102	−0.03	0.43
Ever use of contraceptive (Yes = 1)	Flood	Drought	−0.277*	0.098	0.014	−0.51	−0.05
		Cyclone	−0.240*	0.082	0.010	−0.43	−0.05
	Drought	Flood	0.277*	0.098	0.014	0.05	0.51
		Cyclone	0.037	0.102	0.930	−0.20	0.28
	Cyclone	Flood	0.240*	0.082	0.010	0.05	0.43
		Drought	−0.037	0.102	0.930	−0.28	0.20
Years of schooling	Flood	Drought	−3.941*	0.818	0.000	−5.87	−2.01
		Cyclone	−3.116*	0.683	0.000	−4.73	−1.50
	Drought	Flood	3.941*	0.818	0.000	2.01	5.87
		Cyclone	0.825	0.853	0.598	−1.19	2.84
	Cyclone	Flood	3.116*	0.683	0.000	1.50	4.73
		Drought	−0.825	0.853	0.598	−2.84	1.19

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TABLE 3 (*Continued*) Multiple comparisons (Tukey HSD).

Variables	(I) Name of the area	(J) Name of the area	Mean difference (I-J)	Std. Error	Sig	95% confidence interval	
						Lower bound	Upper bound
Age at first birth	Flood	Drought	0.779	0.923	0.676	−1.40	2.96
		Cyclone	0.644	0.770	0.682	−1.18	2.46
	Drought	Flood	−0.779	0.923	0.676	−2.96	1.40
		Cyclone	−0.135	0.963	0.989	−2.41	2.14
	Cyclone	Flood	−0.644	0.770	0.682	−2.46	1.18
		Drought	0.135	0.963	0.989	−2.14	2.41
Age of first child (months)	Flood	Drought	−16.284	8.313	0.126	−35.94	3.37
		Cyclone	−22.312*	6.941	0.004	−38.72	−5.90
	Drought	Flood	16.284	8.313	0.126	−3.37	35.94
		Cyclone	−6.029	8.673	0.767	−26.53	14.47
	Cyclone	Flood	22.312*	6.941	0.004	5.90	38.72
		Drought	6.029	8.673	0.767	−14.47	26.53

*The mean difference is significant at the 0.05 level.

Those who did perceive a risk of death from EWE significantly prefer no additional children ($\beta = -.235$, $p < .05$) whereas those who had perceived a risk of death from EWE.

The age of the first child has a very slight negative effect on the preference for more children, which is logical, as seen above. Although the effect is small, the preference for having more children is lower when the first child is older. This is probably due to having the number of expected children and maybe particularly male children.

Based on the adjusted R-squared value, the independent variables explain 46.3% variation of the dependent variable, although the following independent variables do not contribute significantly to the preference for more children: respondent's age at first birth, years of schooling, government and NGOs' support to reduce the preference for more children, and the need for more children for recovery. This means that not all factors associated with EWEs have the same influence on fertility preference.

4.3 EWEs and gender preference: associated factors

The GLM analysis (shown in Table 5) reveals that the outcome variable gender preference for future children is statistically significant in the corrected model at $p < 0.05$ (with partial eta squared = 0.141). It shows that the types of EWE do not affect gender preference. If their first child is not a son, it has a significant negative effect on gender preference. This suggests that if people have one child in their total number of living children and especially if their first child is not a male child, then gender preference is impacted by the types of EWE. On the other hand, the perceived risk of dying of children from EWE and intended time for child bearing (before or after EWE) do not affect the outcome variable ($p > 0.05$). Moreover, the results show that whether people had ever use of contraception or not influences their gender preference ($p < 0.05$). Other independent variables do not significantly contribute to gender preference: age of the first child, age at first birth, years of schooling, government and NGO support to reduce preference for more children, need for more children for quick recovery and gender preference due to EWE.

The results of the parameter estimates show that the presence or absence of a son is a statistically significant predictor. Individuals with no son have a higher preference for the gender of future children than individuals with a son ($\beta = 0.219$, $p < 0.05$). However, whether the sex of the first child was male negatively influences the outcome variable. With $\beta = -0.245$, $p < 0.05$, one can interpret this strong negative effect by saying that if their first child is a daughter, the respondents prefer not to express gender preference for a future children. Regarding contraception, those who had not mentioned any contraceptive use had higher gender preferences for future children than those who used contraception ($\beta = 0.139$, $p = 0.05$). However, based on the adjusted R-squared, the independent variables explain only 6% of the variation in gender preference for future children.

4.4 Families with only one child: fertility preference and gender preferences due to EWEs

The results in Table 6 show that there are slightly more respondents preferring more children among people with only one male child than among those with only one female child. However, this proportion is slightly higher in flood-prone area than in the other two areas, but the area and the type of EWE are not statistically significant. People in drought-prone area prefer to have more children without caring whether their only child is male or female.

However, there is a clear difference for areas at risk of cyclone: some people with only one female child are less likely to prefer

TABLE 4 General Linear Model (GLM) and Parameter Estimates for fertility preference.

Dependent variable preference for additional children*** (Yes = 1; No = 0); partial eta^2 = .509 (N = 177)			
Parameter estimates			
Predictors	Parameter	β	Sig
	Intercept	0.999	0.000
Types of EWE** [Cyclone = 3][a]	[Flood = 1]	0.039	0.643
	[Drought = 2]	0.231	0.006
Religion*** [Islam = 1][a]	[Others = 0]	0.230	0.007
Having at least one son*** [Yes = 1][a]	[No = 0]	0.279	0.000
Gender of first child is male*** [Yes = 1][a]	[No = 0]	−0.249	0.001
Perceived risk of death of children due to EWEs*** [Yes = 1][a]	[No = 0]	−0.235	0.002
Intended timing for child bearing [Before EWEs = 1][a]	[After EWEs = 0]	−0.040	0.560
Preference for children to recover from EWEs impacts in future [Yes = 1][a]	[No = 0]	−0.079	0.308
Govt. and NGOs support to lower preferences for more children in future [Yes = 1][a]	[No = 0]	0.085	0.305
Ever use of contraception [Yes = 1][a]	[No = 0]	0.045	0.462
Years of schooling		0.001	0.890
Age at first birth		0.003	0.691
Age of first child***		−0.005	0.000

[a]R^2 = .509 (Adjusted R2 = .463) [Reference category]; *Significant at p-value < 0.1; **Significant at p-value < 0.05; ***Significant at p-value < 0.01.

having more children (0.64) than respondents with only one son (0.93). This may be due to people's reasoning that their first child is female and if they are to have more children, they have the chance of having another female child. They may think that having more than one daughter will be burdensome in the future because their daughters may face sexual harassment during a climatic event. This may be because they have to go to a shelter and stay with other people. It may also be because they fear that they may lose their family reputation and their daughters' future marriage prospects if there is any impropriety, such as sexual harassment and dowry (Ahmed et al., 2019).

The preference to have more children regarding the risk of EWEs is much higher in the cyclone-prone area (36%) than in the other areas (8% and 4%): this preference may be due to frequent experience with severe impacts of the cyclones on agricultural production, housing, and income sources. The area is thus statistically significant whereas the gender of the only child is not at all. In terms of having more children to cope with the impacts of EWEs, people with only one male child in flood-prone area (83%) and drought-prone area (69%) are more numerous to consider that they need more children for rapid recovery from the losses and damages of EWEs than cyclone-prone area. Although these by area and by gender of the only child are not statistically significant, this may imply that people in the flood or drought-prone areas with one male child are more confident in having male than female children to cope with the effects of EWEs in the future but not so for people in the cyclone-prone area. In addition, people who have the perception that support from government and NGOs during EWEs can help them to recover from the loss and damage caused by EWEs are more likely to think that this support can reduce future fertility preferences in the three areas separately and flood-prone areas, and less so in the drought-prone areas.

Regarding intended timing of child bearing (before or after EWEs), respondents in drought- and cyclone-prone areas (either with only one daughter or one son) are more numerous to intend to have another child after EWEs. However, people in flood-prone area with only one female child have a high preference for another child before an EWE (67%), while those with only one male child intend to have another child after the EWEs. Preferring to have another child after the EWEs for the respondents having only one male child may be due to their perception that they do not want to face the challenges of an EWE with two male children because of the risk of their male child dying during an EWE.

The difference between areas is very significant whereas the difference according to the gender of the only is not the same when it comes to contraception: one-third of people living in flood-prone area uses contraception, which is much less than people living in drought-prone area (63%) and a cyclone-prone area (71%). This may be because their area is flooded and contraceptives are less available and accessible. Although the difference according to the gender of the only child is not statistically significant, it can be noted that people living in cyclone-prone area with only one male child are much more likely to use contraceptives (86%) than people living in flood-prone area with only one male child (28%). This opposite result suggests that people living in cyclone-prone area may think that

TABLE 5 General linear model (GLM) and parameter estimates for further gender preference.

Dependent variable any gender preference (Yes = 1; No = 0); partial eta^2 = .141 (N = 177)			
Parameter estimates			
Predictors	Parameter	β	Sig
	Intercept	1.066	0.000
Types of EWE [Cyclone = 3][a]	[Flood = 1]	−0.070	0.411
	[Drought = 2]	0.037	0.662
Religion [Islam = 1][a]	[Others = 0]	−0.012	0.891
Having at least one son*** [Yes = 1][a]	[No = 0]	0.219	0.006
Gender of first child is male*** [Yes = 1][a]	[No = 0]	−0.245	0.001
Perceived risk of dying of children due to EWEs [Yes = 1][a]	[No = 0]	−0.034	0.660
Intended timing for child bearing [Before EWEs = 1][a]	[After EWEs = 0]	−0.071	0.303
Preference for children to recover from EWEs impacts in future [Yes = 1][a]	[No = 0]	−0.068	0.385
Govt. and NGOs support to lower preferences for more children in future [Yes = 1][a]	[No = 0]	0.003	0.974
Ever use of contraception** [Yes = 1][a]	[No = 0]	0.139	0.027
Years of schooling		−0.007	0.321
Age at first birth		−0.007	0.266
Age of first child***		0.000	0.743

[a]R^2 = .141 (Adjusted R^2= 0.061)"Reference category"; *Significant at < 0.1; **Significant at < 0.05; ***Significant at < 0.01

having more children during EWEs is burdensome. This may also be due to higher levels of schooling and awareness of family planning in this area than in other areas.

Summing up, the area of the respondents who have only one child, and thus the type of EWE, has a very significant effect on the three following variables: preference for having more children due to the risk of EWEs, intended time for child bearing and ever use of contraception. By contrast, gender of this only child has no significant influence on the variables considered. However, the relation is close to be significant for the preference for additional children in the future and for the intended time for child bearing (significant level of .070 and .089 respectively). We also asked people in the three areas whether they have a gender preference and whether they prefer a male children because of EWEs. Table 7 shows that for gender preference due to EWE, there is no statistically significant difference among the three areas. Nevertheless, the mean score was slightly higher for people in flood- and cyclone-prone areas (52% and 50% respectively) with only one female child than people in the drought-prone areas (36%). However, people with only one female child in the drought-affected area were the least numerous to prefer a particular gender because of EWE's risk compared to the other areas. This may be because they are not exposed to severe droughts that often, unlike people in the flood and cyclone area who are exposed to these events very often, leading them to have gender preferences. In a study conducted in a flood-prone area of Bangladesh, Ahmed et al. (2019) mentioned that the increasing occurrence of extreme weather events such as flash floods and cyclones affects poor households in vulnerable areas; Haq (2019) collected the historical numbers of different extreme weather events for Bangladesh from the Flood Forecasting and Warning Centre (FFWC) and Planning Commission of Bangladesh for the three decades of 1980s, 1990s, and 2000s. It showed that the country faced seven drought events during these three decades, but the number of floods was the highest and the total number of floods and cyclones were 28 and 18 respectively.

People were also asked whether they preferred male children and how many, and whether this was due to EWEs. The results show that people prefer on average less than one male child, with the mean being 0.85 (flood), 0.74 (drought) and 0.57 (cyclone) respectively. Furthermore, the sex of the sole child influences the preferred number of sons, this number being significantly higher (around 1) for respondents having only one daughter. In addition, respondents in the three areas with only one female child have a low preference for additional daughters compared to respondents with only one male child. On the other hand, people in the EWE's risk areas prefer at least one male child since they currently have only one child, especially if they have a female child. In addition, there is a statistically significant difference between respondents' preferred number of additional daughters and sons in terms of the sex of the child already born for the three areas.

In all three zones, the vast majority of respondents want a child of each sex, slightly more for a son if they already have a daughter, especially in the flood zones, even in the drought zones. In the case of the cyclone zone, respondents with one male child want one daughter.

TABLE 6 Mean comparisons for fertility preference by areas and gender of the one child.

Areas	Gender of the sole child	Preference for additional children (Yes = 1)	Preference for having more children due to the risk of EWEs (Yes = 1)	Intended time for child bearing (1 = Before an EWE)	Government support to recover from loss and damage (Yes = 1)	Preference for children to recover from EWEs impacts in future (Yes = 1)	Govt. and NGOs support to lower preferences for more children in future (Yes = 1)	Ever use of contraception (Yes = 1)	Any gender preference (Yes = 1)
Flood-prone	Female (N = 21)	0.90	0.10	0.67	0.81	0.67	0.67	0.38	0.86
	Male (N = 18)	1.00	0.06	0.39	0.94	0.83	0.67	0.28	0.94
	Sig	0.188	0.653	0.087	0.219	0.246	1.0	0.508	0.384
Drought-prone	Female (N = 11)	0.82	0.09	0.18	0.82	0.36	0.27	0.64	0.91
	Male (N = 13)	0.85	0.00	0.15	0.69	0.69	0.46	0.62	0.85
	Sig	0.862	0.287	0.862	0.50	0.117	0.363	0.920	0.659
Cyclone-prone	Female (N = 14)	0.64	0.29	0.21	0.71	0.57	0.57	0.57	0.93
	Male (N = 14)	0.93	0.43	0.14	0.64	0.50	0.50	0.86	0.86
	Sig	0.069	0.449	0.637	0.699	0.717	0.717	0.101	0.558
Total	Female (N = 46)	0.80	0.15	0.41	0.78	0.57	0.54	0.50	0.89
	Male (N = 45)	0.93	0.16	0.24	0.78	0.69	0.56	0.56	0.89
	Sig	0.070	0.965	0.089	0.956	0.227	0.909	0.600	0.971
Sig. (by areas)		0.130	0.001	0.001	0.159	0.138	0.078	0.004	0.962

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TABLE 7 Mean comparisons for son preference by areas and gender of the only one child.

Areas	Gender of the sole child (N = 91)	Gender preference for future children (N = 91; Yes = 1)	If yes, preferred number of additional daughters (N = 73)	If yes, preferred number of additional sons (N = 73)	Preference for sons due to EWEs (N = 43; Yes = 1)
Flood-prone area	Female (N = 21)	0.52	0.25	1.19	0.92
	Male (N = 18)	0.50	0.94	0.53	0.78
	Sig	0.886	0.000	0.003	0.393
Drought-prone area	Female (N = 11)	0.36	0.00	1.11	1.00
	Male (N = 13)	0.46	0.80	0.40	0.83
	Sig	0.646	0.001	0.003	0.516
Cyclone prone area	Female (N = 14)	0.50	0.22	0.89	0.83
	Male (N = 14)	0.43	1.00	0.33	1.00
	Sig	0.717	0.000	0.031	0.341
Total	Female (46)	0.48	0.18	1.09	0.90
	Male (45)	0.47	0.92	0.44	0.86
	Sig	0.913	0.000	0.000	0.644
Sig. (by areas)		0.761	0.375	0.286	0.884

5 Concluding discussion

This study examines how EWEs affect fertility preferences and gender preferences in three EWE-affected areas (flood, drought and cyclone) of Bangladesh. First, the study aims to show whether fertility preferences and gender preferences differ according to the type of EWE among individuals with at least one surviving child. Second, for the respondents having only one child this research sought to understand whether the sex of this single child affects fertility and son's preferences.

The GLM analysis reveals that all predictors considered in the study did not have a simultaneous effect on fertility preferences. The analysis shows that extreme weather events (EWE) play a significant role in determining fertility preferences, while the extent to which predictors influence the outcome variables varies across the three regions. Analysis of variance reveals that people in flood- and drought-prone areas have a relatively higher preference for having more children than those in cyclone-prone areas. Nevertheless, the mean number of children ever born is significantly different across the three areas. The findings of the present study from three EWEs-exposed regions suggest that the actual experience of EWE is important in determining whether people want to have more children.

Mean comparisons show that people living in flood-affected area are more likely than those in other areas to believe that receiving sufficient support from the government and NGOs can reduce their preferences for future additional children, and are less likely to be using contraception. In drought- and cyclone-prone area, the decision to have a child after a waiting period may be due to the risk of weather events or the inability to place a young child in a safe place. Those who have only one daughter tend to be less inclined to have more children in cyclone-prone areas than in other areas. This is because they may perceive the possibility to have a second female child and believe that having more than one girl in the future will be a burden. This is because during a cyclone, they may have to stay with others, which may expose girls to unexpected behaviors in the future. Ahmed et al. (2019) and Carrico et al. (2020) suggest that early marriage is a coping strategy against EWEs in Bangladesh due to fears that the family's reputation will be damaged by sexual harassment in shared shelters during cyclones.

Not all predictors considered in the GLM analysis had a simultaneous effect on gender preference. The findings suggest that the experience of EWE influences whether people prefer to have children of a particular gender, especially a son. However, analyses of variance show that gender preferences are not statistically significant but is more prevalent among the three areas. Indeed they show, with some variation, a high gender preference, especially for sons due to EWEs in all three zones. If there is not at least one son and if the first child is not a son, this influences people in areas vulnerable to EWEs to have more children, especially sons, as reliable future security against EWEs. This preference may be related to a lack of government and NGOs' support during or after EWEs. These factors can also contribute to low contraceptive use in flood-prone areas, along with other associated factors such as low education, religious beliefs, low availability and accessibility of contraceptives, and perceived negative side effects of contraceptive use.

Comparing the averages across areas for respondents with only one son and with only one daughter shows a significant difference in the intended timing of childbearing. In the flood-prone area, people with only one son tended to prefer to have a second child after the flood, possibly because they feel they do not want to face the challenge of an EWE with two male children. This may be due to the perception that the risk of a male child dying during the flood is higher than in other areas. The reliance on male children may be due to their frequent exposure to EWEs that causes more loss and damage, as well as the perception of more sons as future security and social protection in times of crisis (Finlay, 2009; Haq, 2018). Regarding ever use of contraception, results imply that in flood-prone area, those who prefer to have sons generally do not use contraceptives as compared to other areas. To some extent, this may also be due to poor accessibility in remote areas due to lack of transportation during extreme flooding. The tendency to have higher numbers of sons in flood-affected area may be due to the lack of adequate support and assistance (Biddlecom et al., 2005; Bremner et al., 2009). This is likely because local leaders control the distribution of aid and resources, and there is a certain amount of corruption.

Previous studies, such as Cain (1981) and Cleland et al. (1994) in Bangladesh, have examined the costs and benefits of having children that affect fertility preference and gender preference as an adaptation measure to economic crisis and future social security in old age. However, few studies have separately examined the effects of economic, social, and climate change-related factors on preferences for having more children and gender preferences for future children across different types of climatic conditions (Grace, 2017). However, the intensity and severity of EWEs' impacts are gradually increasing, causing loss and damage in EWEs-prone areas in Bangladesh.

The study suggests that the effect of religion and education on fertility and gender preferences may not be significant given the low levels of education and Muslim majority in the three regions. It is already known that years of education and contraceptive use can significantly influence the choice to have additional children, but there is still a need to explore how both factors influence the preference for a particular gender for additional children by linking people's experience with the impacts of different extreme weather events by collecting data from married women of childbearing age and married men in different age groups. In addition, this study included both male and female respondents and focused on a particular age group (women: 20–24; men: 30–34), but did not examine gender differences in perceptions of fertility preferences and gender preferences by type of EWE.

These days, it might be challenging to determine whether locations are entirely protected from catastrophic weather events. There were several locations that were inundated in Bangladesh in 2022 that had never seen flooding before, and Sylhet experienced it even more severely. Based on GIS data and maps, it could be feasible to classify locations according to their severity and use control areas that are very little impacted by EWEs, particularly flooding, as a control variable. However, the current study did not consider the design when preparing the present study and only took into account a sample survey of the three regions in order to see the variations between the areas. The findings demonstrate variations among the three region, particularly flooding area with other two areas in terms of fertility preference and gender preferences. Future studies with larger samples and information from both vulnerable and non-vulnerable areas, and using both quantitative and qualitative methods, may provide a better understanding of the complex mechanisms between climate extremes and fertility, not only in Bangladesh but also in other developing countries.

Data availability statement

The study's gathered data from the respondents cannot be shared since respondents were informed during the data collection that their information would be kept confidential and not disclosed. The responders then gave their permission to collect the relevant data for the study.

Ethics statement

The interviewer informed the participants about the objectives of the study and confirmed that the data provided by the participants will be confidential and used only for the study. They were also informed that the results and findings of the study will be published. They were also asked to give their consent to participate in the study. The university in Bangladesh did not have an ethics committee at the time the data was collected, thus it was not necessary for the research on human subjects to get ethical review and approval in line with institutional regulations. To protect the privacy, confidentiality, and potential sensitivity of the participants' information, we adhered to all accepted standards when gathering data from them.

Author contributions

SA: conceptualization, literature review, data curation, data analysis, first draft preparation, revision, finalization, validation, and final draft preparation.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Appendix A:Survey questionnaire

1. Gender: i) Male ii) Female
2. Religion of the interviewee: i) Islam ii) Hindu
3. Education (Years of Schooling):
4. Age at first birth (Years):
5. Age of first child (Months):
6. Is your first child male? i) Yes ii) No
7. Do you have at least one son? i) Yes ii) No
8. Do you have only one child? i) Yes ii) No
9. If yes, what is the gender of the sole child? i) Male ii) Female
10. What is the type of extreme weather event you are experienced with in your locality? i) Flood ii) Cyclone iii) Drought
11. Do you think that there is perceived risk of dying due to EWEs? i) Yes ii) No
12. Do you think that the impacts of EWEs influencing gender preference? i) Yes ii) No
13. What is your intended time for child bearing? i) Before EWEs ii) After EWEs
14. Do you prefer children to recover from EWEs impacts in future? i) Yes ii) No
15. Do you think that govt. and NGOs support to lower preferences for more children in future? i) Yes ii) No
16. Do you have experience using contraceptives? i) Yes ii) No
17. Do you prefer additional children? i) Yes ii) No
18. Do you have gender preference for future children? i) Yes ii) No
19. If yes, preferred number of additional daughters?
20. If yes, preferred number of additional sons?
21. Do you think that the preference for sons is due to EWEs? i) Yes ii) No