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Is Fertility Preference Related to Perception of the Risk of Child Mortality, Changes in Landholding, and Type of Family? A Comparative Study on Populations Vulnerable and not Vulnerable to Extreme Weather Events in Bangladesh

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Abstract

This study addresses how perception of risk of child mortality, land ownership and household type influence fertility preferences. The study focuses on four distinct villages: two vulnerable to cyclones and floods and two not usually subject to the impacts of extreme weather events (EWEs). The study uses a mixed-methods approach in collecting relevant information from 759 randomly selected ever-married women at reproductive age who had at least one child and were living with their husband during the field survey. The descriptive findings demonstrate that fertility preferences vary regarding perceived risk of child death, land ownership and household type, and that the influences of these factors vary for areas vulnerable to EWEs and not vulnerable to EWEs. Binary logistic regression analysis reveals that perceived risk of child death from EWEs and land ownership are the significant covariates in areas vulnerable to EWEs. In contrast, experience with child death, land ownership and household type are the most influential covariates explaining variation in fertility preferences in the areas not vulnerable to EWEs. The findings of the study can inform policy recommendations in terms of effective disaster management programs and family planning initiatives during climate-related events.

Keywords

Extreme weather events, fertility preferences, perception of risk of child death, changes in landholding, household type, vulnerable areas

1. Introduction

Natural disasters attributed to climate change are now a common phenomenon worldwide. The earth's average atmospheric temperature has increased by 0.15°C to 0.2°C in the last 100 years (Mendelsohn 2007) and is predicted to increase between 0.3°C and 4.8°C by the end of the current century (Hartmann et al. 2013). Rainfall patterns have changed globally and locally (Hulme et al. 1998; Rodríguez-Puebla et al. 1998), and the incidence of extreme weather events have increased. From 1997 to 2016, natural disasters caused more than 524 thousand human deaths and resulted in monetary losses of US$ 3.16 trillion. 354 natural disasters were reported as the annual average for 2007-2016, and 335 disaster events occurred in 2017 where Asia faced 136 disaster events (CRED 2018). Of the EWEs, flood and storms were the two most common worldwide. Of the 315 climate-related and geophysical disaster events in 2018, floods were most numerous (127 events), followed by storms (95 events) (CRED 2019).

With the adverse effects of climate change and extreme weather events (EWEs)[1] population indicators, such as mortality, migration and fertility, are undergoing significant change (Frankenberg, Laurito and Thomas 2015; Frey and Singer 2010; Jiang and Hardee 2011). Geographers and demographers have already examined the effects of climate variability on health (Bakhtsiyarava, Grace and Nawrotzki 2018; Grace et al. 2015), migration (Gray and Mueller 2011; Gray and Wise 2016; Thiede, Gray and Mueller 2016) and mortality (De Waal, Taffesse and Carruth 2006). Fertility dynamics under climate change, however, has not received much scholarly attention. Exploring how climate variability or EWEs may affect fertility, and linking climate with human fertility and reproductive health research at the individual and community levels, might provide insight into the proximate determinants of fertility dynamics under climatic change and contribute to the development of policy in the face of spatial and temporal variability (Grace 2017). As EWEs are increasing in frequency and intensity, affecting human settlements and population trends, there is a need to explore the underlying mechanisms impacting fertility dynamics at the household level, specifically the effects of EWEs on the perceived risk of child mortality, changing landholding patterns, and changing household types (e.g., from joint to nuclear households in areas that are susceptible to climate variation and EWEs) (Jiang and Hardee 2011: 300).

The world has shown a remarkable decline in total fertility rates (TFRs) over the last 50 years, halving from 5.5 in 1950 to 2.49 in 2015 (Roser 2019). Eighty per cent of the world's population now lives in countries where the TFR is below three children per woman (Roser 2019). The pace of fertility decline in some countries is, however, slower than the pace of fertility decline in other regions of the

[1] Nagy et al. (2018) designated extreme climatological, hydrological, and meteorological events as "EWEs."

world (Shapiro and Hinde 2017). Regarding the relationship between EWEs and fertility, studies have linked environmental factors to preferred household size and family planning practices (Aggarwal, Netanyahu and Romano 2001; Arnocky, Dupuis and Stroink 2012; Ayoub 2008; Biddlecom, Axinn and Barber 2005; Ghimire and Mohai 2005; Haq 2013; Haq, Vanwing and Hens 2010; Loughran and Pritchett 1997). For instance, researchers such as Biddlecom, Axinn and Barber (2005) and Ghimire and Mohai (2005) have shown that poor environmental conditions and increasing environmental scarcity induces contradictory effects on the demand for children and fertility. The impact of fuelwood and water scarcity on fertility has been found to be positive in South Africa (Aggarwal et al. 2001) and Nepal (Biddlecom et al. 2005), though another study in Nepal showed a negative association (Loughran and Pritchett 1997). Ayoub (2008) showed a positive association between water scarcity and fertility in Honduras and Nepal. To cope with such scarcities and the increasing time needed for natural resource collection, indigenous married men and women living in a reserved forest in Bangladesh preferred to have additional children, hoping particularly for sons (Haq 2013). Fertility rates in the wake of natural disasters have been shown to decrease (Fukuda et al. 1998; Hamamatsu et al. 2014; Lin 2010; Tan et al. 2009), whereas other studies have shown that fertility increases after disaster events (Cetorelli 2014; Davis 2017; Nandi, Mazumdar and Behrman 2018; Nobles, Frankenberg and Thomas 2015; Rodgers, John and Coleman 2005; Simon 2017).

The present study considers that people who regularly experience the impacts of EWEs and disaster-related child mortality (Nobles et al. 2015) may prefer to have more children as a positive response (Finlay 2009) and an insurance against the anticipated risk (Frankenberg et al. 2015) than others not regularly affected by EWEs. Doveri (2000), Gebru (2014) and Schutjer and Stokes (1984) argued that large farm size increases demand for children in order to maintain the land and increase productivity. Doveri (2000) also mentioned that more landholdings may lead to lower fertility preference, because landholdings are considered as increasing the household's security. On the other hand, in Kenya, women who lose their land – for example, due to land erosion, climate change or land scarcity – has been shown to have low fertility preference, whereby the loss induces a decision to have a smaller family (Shreffler and Dodoo 2009).

We also consider that EWEs may compel extended-family households to break up. For example, a year after Hurricane Katrina, half of the adult children no longer lived with their pre-Katrina household head parent (Rendall 2011). Climate-change induced economic pressure can place extended families at high risk of breaking up (Richards, White and Tsui 1987; White and Rogers 2000). The present study aims to see whether/how the impacts of EWEs contribute to change in people's perception of the risk of child mortality, in land ownership and in household type, all of which can impact fertility preference. We selected Bangladesh as a case study to explore this relationship because, according to the Global Climate Risk Index[2] (CRI) for 2018, Bangladesh, with 187 climatic events, is among the 10 countries in the world most affected by EWEs from 1997 to 2016 (Eckstein, Künzel and Schäfer 2017). We selected two types of study villages: one vulnerable to EWEs and the other not vulnerable to EWEs. Our study yields interesting findings that can stimulate new arguments within the existing literature on the relationship between population and environment. The study's detailed exploration deepens our understanding of the complex relationship between the impacts of EWEs on the perception of the risk of child mortality, land ownership, types of household structure, and fertility preference. The findings have policy implications for decision-makers in the field of disaster management and on their provision of family planning programs.

This paper proceeds as follows. In the next section, we describe the trends and scenarios of EWEs in Bangladesh and outline spatial variations in the fertility rate in Bangladesh, as well as discuss the significance of the study. We then present a literature review, focusing on the linkages between fertility preference and EWEs, people's perceptions about child mortality, land ownership, and changes in household type. This is followed by a methodology section, which provides a detailed discussion of the quantitative methods used in data collection. We then present the results and analysis based on sampled data. Finally, we conclude with suggestions for policy implications based on the empirical findings of the study.

2. Study context: the case of Bangladesh

2.1 Extreme weather events in Bangladesh

Bangladesh is one of the countries most vulnerable to climate change and climatic variability (Pouliotte, Smit and Westerhoff 2009). Extreme climatic events such as floods, cyclones, heavy rainfall, riverbank erosion and droughts frequently occur in Bangladesh (Asada and Matsumoto 2009; GoB 2010; Habib 2011; Islam and Neelim 2010; Salauddin and Ashikuzzaman 2012; Shahid 2010; Thakur, Laha and Aggarwal 2012). These events seriously affect the livelihoods of vulnerable populations (Ayeb-Karlsson et al. 2016; Garai 2014; Parvin et al. 2016). Particular factors, including geographical position, a tropical monsoon climate and a peculiar natural setting make Bangladesh vulnerable to frequent cyclones and storm surges (As-Salek 1998; Madsen and Jakobsen 2004; Paul and Rahman 2006; Paul 2009). Such events are quite common in Bangladesh (Ali 1999; Paul 2009; Paul and Routray 2013). For example, a severe cyclone occurs there almost once every three years (Ali 1999). Bangladesh experiences several types of floods: riverine, cyclonic, flash and rainwater

[2] The CRI is calculated based on four indicators: 1) number of deaths, 2) number of deaths per 100,000 inhabitants, 3) the sum of losses in USD in purchasing power parity (PPP), and 4) losses per unit of Gross Domestic Product (GDP).

floods (Ahmad et al. 2001; Choudhury, Paul and Paul 2004; Haque and El-Sabh 2012; IPCC 2012). Of the aforementioned EWEs, we focus on floods and storms since these are the two most extreme kinds of weather events, both in Bangladesh and worldwide. EM-DAT (2018) disaster records reveal that Bangladesh experienced 315 events (floods, storms, droughts, earthquakes, landslides and extreme temperature-related events) from 1900 to 2018, with storms accounting for the highest number of events (177), followed by floods (94).

2.2 Spatial variations of fertility in Bangladesh

The total population of Bangladesh was 158 million in 2014 (NIPORT et al. 2016) and is projected to reach about 202 million by 2050 (UN 2015). Although the TFR of 2.3 births per woman was steady in 2011 and 2014, in 2014 there existed substantial differences in fertility rates between rural (2.4) and urban regions (2.0) in the country (NIPORT et al. 2016). Variation also exists between the country's seven administrative divisions.[3] For example, Sylhet division, located in the northeast, has the highest TFR (Islam, Islam and Padmadas 2010). According to Bangladesh Demographic and Health Survey (BDHS) reports, Chittagong division, in the east, has lower contraceptive use than Rajshahi and Khulna, in the west, where there is a consistently low level of fertility with a higher level of contraceptive use including in 2014. There are regional variations[4] in fertility (Alam et al. 2018; Deb, Kabir and Kawsar 2011; Kabir et al. 2009) and in its proximate determinants, such as contraception, which has the highest effect, translating into a 54 per cent reduction of fertility across all regions, although the effect is not uniform, with the highest in Khulna division and the lowest in Sylhet division. Postpartum infecundability also causes a 39 per cent reduction in the fertility rate (Kabir et al. 2009). Alam et al. (2018), from a cross-sectional survey selected married women of reproductive age (15–49 years) having at least one child and living with their husband in a rural area for at least 12 months before the survey, found that the Chittagong division has the lowest proportion of modern contraceptive users (54.9%) with identified factors (e.g. family planning attitude, social influence, decision-making process, fertility preference, women's empowerment) compared to Dhaka (59.5%) and Rajshahi (65.5%). The 2007 BDHS and 2014 BDHS show a similar differential for the three districts Khulna, Sylhet and Chittagong (Deb et al. 2011; NIPORT et al. 2016).

Previous studies on fertility have examined a broad range of issues linked to fertility: education (Bairagi and Datta 2001; Chaudhury 1984; Khuda and Hossain 1996; Miah 1993; Roy and Hossain

[3] The administrative units of Bangladesh are categorized as divisions, districts, and *upazilas* (sub-districts). Each division includes city, urban, and rural areas and is named after the major city within its jurisdiction, which also serves its administrative headquarters. Each division is further split into several districts, which are then further sub-divided into *upazilas*. There are eight divisions in Bangladesh – Dhaka (capital), Chittagong, Khulna, Rajshahi, Rangpur, Sylhet, Barisal, and Mymensingh – with a total of 64 districts and 491 *upazilas*. Mymensingh was split off from the Dhaka division in 2015; it does not specifically figure in our discussion as it was still part of Dhaka division during the Bangladesh Demographic and Health Survey of 2014.

[4] The administrative divisions studied are Barisal, Chittagong, Dhaka, Khulna, Rajshahi, and Sylhet.

2017; Saha and Bairagi 2007), employment (Hasan and Sabiruzzaman 2008; Khuda and Hossain 1996; Miah 1993), age at marriage (Ahmed et al. 2007; Nahar, Zahangir and Islam 2013), contraceptive prevalence (Alam et al. 2018; Rahman, Mostofa and Hoque 2014; Saha and Bairagi 2007), poverty (Hasan and Sabiruzzaman 2008; Saha and Bairagi 2007; Shaikh and Becker 1985), land ownership (Latif and Chowdhury 1977), child mortality (Kabir et al. 2001), family type (Amin 1998), and religion (Miah 1993; Sahu et al. 2012; Shaikh and Becker 1985). In this study, we incorporate land ownership, household type, and child mortality, noting Amin's (1998: 202) statement that "the rise of landlessness is a considerable force for change in the timing of formation of new households, and in the overall distribution of living arrangements, a concomitant increase in children's survival to adulthood, broadening the availability of sons for support of the elderly, is a counterbalancing influence."

3. Literature Review

3.1 Relationship between extreme weather events and fertility preference

A number of studies demonstrate that natural disasters such as earthquakes and tsunamis (e.g. Carta et al. 2012; Hamilton et al. 2009; Nobles et al. 2015), severe storm events (e.g. Buekens et al. 2006; Tong et al. 2011) and flash floods (Haq and Ahmed 2018) influence couples' fertility timing and fertility preference. Several post-hurricane fertility studies in Nicaragua and the United States reveal that fertility may increase or decrease after strong storm events (Davis 2017; Cohan and Cole 2002; Evans et al. 2010; Hamilton et al. 2009). Investigating the effect of Hurricane Mitch in Nicaragua on the reproductive health of women, fertility was found to increase in the first two years, and then "normalizes between disaster and non-disaster areas 4 to 6 years after the storm" (Davis 2017: 448). Collecting data from 1975 to 1997, another study revealed a significant increase in birth rates during the year following Hurricane Hugo in 24 affected areas where the effects were significant (Cohan and Cole 2002). Another case study of the Italian village of L'Aquila found a 27 per cent jump in births 9 to 15 months after the earthquake in 2009 (Carta et al. 2012). A study on the 2003 earthquake in Bam in south-central Iran found a decrease in the local fertility rate in 2004, followed by a rise in 2006–2007 (Hosseini-Chavoshi and Abbasi-Shavazi 2015). A further study on India, Pakistan, and Turkey discovered a higher fertility response in earthquake-exposed areas (Finlay 2009). A study in India (Nandi, Mazumdar and Behrman 2018), investigating the effect of the 2001 Gujarat earthquake on fertility behavior, found a higher childbirth rate in the earthquake-affected areas than in unaffected neighboring areas. Therefore, one can infer that different types and/or severities of events lead to different fertility responses.

Haq and Schoumaker (2019) examined the relationship between event type (river flooding, flash flooding, and tidal flooding) and severity (flooding is severe, moderate, mild, or absent) of flooding and total marital fertility rate (TMFR) in Bangladesh. They used BDHS data from the 1999, 2004, 2007, 2011, and 2014 surveys, as well as GIS coordinates. A higher TMFR was observed in areas affected by flash flooding, as well as by severe flooding, with the slight change TMFR in areas where there was severe flash flooding by controlling for socioeconomic variables (education, standard of living, place of residence). Given the lower contraceptive prevalence rate and higher ideal family size in these areas, this higher TMFR may be a response to climatic risks (Haq and Schoumaker 2019).

Fertility is also responsive to droughts, famines, and changes in economic and political situations. For example, fertility rates declined following droughts and associated famines in Bangladesh, China, Ethiopia, Finland, and Tajikistan. In Ethiopia, a decrease in conception probabilities was evident during years of drought and famine, between 1970 and 1980 (Lindstrom and Berhanu 1999). Similarly, fewer conceptions were reported in January to May in Finland during the 1967–1968 famine that resulted in extreme food shortages (Fellman and Eriksson 2001). A similar effect on fertility was experienced during the historic 1958–1961 famine in China (Ashton et al. 1984; Coale 1981). The birth rate in 1950–1957 was 35.7 per 1,000, dropping to 23.8 per 1,000 during the famine, and then rebounding post-famine in 1962–1971 to 35.9 per 1,000 (Coale 1981).

3.2 Child mortality and fertility preference

According to Malthusian theory, population growth is controlled by positive checks and preventive checks. War, famine and disease are identified as positive checks because they increase the mortality rate, whereas preventive checks, such as birth control and celibacy, act to reduce fertility rates (Malthus 2000). Applying ideas about insurance mechanisms and replacement, Finlay (2009) argues that fertility is responsive to both natural disasters and child mortality. In her study on earthquake effects in India, Pakistan, and Turkey, she found a positive fertility response to child mortality. Other studies show that people who have lost children during disasters prefer replacement (Nobles et al. 2015; Preston and Barrett 1978) and consider more children as an insurance against the anticipated risk (Frankenberg et al. 2015). In Indonesia, Nobles et al. (2015) found that women who had lost one or more children during the 2004 Indian Ocean tsunami were more likely to have additional children after the disaster. Women who had no children before the tsunami "initiated family-building earlier in the communities where tsunami-related mortality rates were higher" (Nobles et al. 2015: 15). Poorer groups or countries who are disproportionately more vulnerable to natural disasters (Jiang and Hardee 2011) will have a tendency to bear more children to replace those lost during such disasters (Finlay 2009) and as insurance against the adverse impacts of natural disasters or risky environments (Cain

1981, 1983, 1986; Frankenberg et al. 2015; Pörtner 2008). However, experiences of loss of family members or other community members to a natural disaster may shape perceptions of child loss in future disasters (Neria, Nandi and Galea 2008; Norris et al. 2002). Based on the literature, we hypothesise that the perceived risk and experience of child mortality and fertility preference may be higher in our case study areas vulnerable to EWEs compared to those areas not vulnerable to EWEs.

3.3 Landholding and fertility preference

Applying the *land labor demand (LLD) hypothesis* of Schutjer and Stokes (1984), Gebru (2014), in his study in Ethiopia, revealed that a larger farm size contributes to the demand for additional children in order to maintain the land and ensure its productivity. Doveri (2000) argued that the greater the number of children, the higher the potential to increase farm profits through greater labor availability. On the other hand, more landholdings can also lead to lower fertility preference because landholding itself can provide household security (Doveri 2000). Carr et al. (2006), in their study on the Ecuadorian Amazon frontier, found that fertility preference was low among women who had lost land recently. Similarly, in rural Kenya, Shreffler and Dodoo (2009) found that land scarcity may result in couples making the decision to have smaller families. In another study in Malawi, Behrman (2017) found that land ownership by women is associated with an increase of 14 per cent chance that they can participate in reproductive health decision-making. Another study by Chege and Susuman (2016) in Kenya concluded that landholding induces higher fertility preferences in women. High fertility preference, therefore, is considered a strategy for meeting labor demands among poor households (Filmer and Pritchett 2002; Sasson and Weinreb 2017).

EWEs in Bangladesh – such as flooding, cyclones and riverbank erosion – are factors that lead to people losing their land. Satellite images of major rivers in Bangladesh (i.e., Ganges, Brahmaputra, and Middle-Meghna) show that an area of 106,300 hectares was lost due to flooding and riverine erosion between 1982 and 1992. The net erosion rate from accelerated flooding was, therefore, estimated at 8,700 ha per annum (Agarwala 2003). Floods and riverbank erosion also damage agricultural lands and crops (Ayeb-Karlsson et al. 2016). Floods contribute indirectly to land ownership and wealth. Crop damages resulting from disasters force poor and vulnerable landowners to sell land and assets to wealthy landowners (Karim 1995) in order to manage their credit and cope with and adapt to the adverse impacts of disasters. This leads to further inequality and concentration of land ownership (Shafi 2010). Like floods and river erosion, cyclones also influence land loss. Cyclone-induced damage may bring about a colossal loss of standing crops and may render fertile agricultural land unsuitable for future cultivation. These effects may lead people who count on agricultural production to varying extents to avoid cultivating and to sell off land at lower than market prices. Seasonal drought, which is acute in the northwestern part of Bangladesh, may have a similar effect (Shafi 2010). Given the influence of EWEs on land loss and land ownership, in our study we expect that fertility preference adjusts according to the situation. In other words, we assume that having agricultural land with productive capacity may lead to differential fertility preferences in areas vulnerable versus not vulnerable to EWEs.

3.4 Household type (or structure) and fertility preference

In our study, we consider the nuclear family as one married couple with their unmarried children. And we assume that the joint or extended family (hereafter referred to as "joint family") may contain other married couples and relatives (Amin 1998: 205). Studies have found some association between household or family type – joint or nuclear – and fertility outcomes and preferences. Kannan and Nagarajan (2008), in their study in India, and Stokes, LeClere and Hsieh (2008), in their study in Taiwan, revealed higher fertility in joint families than in nuclear families. In contrast, in another study among Iranian peasant women, researchers found that women living in extended families have lower fertility (5.3 children) compared to their counterparts living in nuclear families (6 children) (Aghajanian 1978). Studies conducted in India and Pakistan also revealed that women living in nuclear arrangements had higher fertility than those living in joint family arrangements (Durr-E-Nayab 1999; Jejeebhoy 1984).

EWEs may influence changes in household structure. Rendall (2011) showed that Hurricane Katrina had a strong effect on household breakup, mainly for extended family households. Half of all adult children were no longer living with their pre-Katrina household head parent just over a year after Katrina, and two-thirds of pre-Katrina households with two or more members had at least one member move out of the pre-Katrina residence. The breakup was evident for households regardless of the level of physical damage (Rendall 2011). Given that extended families are generally at higher risk of breakup (Richards et al. 1987), such breakups may be induced by disaster-induced economic pressures (White and Rogers 2000) and psychological stresses (Weisler, Barbee and Townsend 2006) on individuals and families. With the effects of EWEs and other natural disasters on household structure, we expected to observe a prevalence of nuclear households in vulnerable areas, as well as a variation in fertility preference according to household structure and vulnerability to EWEs.

4. Methodology

4.1 Study design

A cross-sectional survey was conducted in rural areas in two of Bangladesh's divisions: Sylhet and Chittagong.

4.2 Sample size and target population

Using the sample size formula $n=Nz^2pq/ (Nd^2+Z^2pq)$[5] (Islam 2008), we calculated the total sample size for this study. The total population, that is, married women with the criteria, for all study villages is 2,893 (Lamagaon 629; Kazirgaon 633; Paschim Patramati 682; Khankanabad 949), and the derived sample size is 779. A sampling fraction (f = n / N = 779/2893 = 3.71) was used to ensure that the sample from each village was proportionate. Using the allocation method (Islam 2005), the sample size was determined for each village[6]: Khankanabad 255, Lamagaon 169, Paschim Patramati 184, and Kazirgaon 171. The final number included in the analysis was 759 rather than 779 women after removing those not available during the survey and those who refused to participate in the study (Khankanabad 6 women, Lamagaon 4, Paschim Patramati 5, and Kazirgaon 5).

Our study targeted ever-married women of reproductive age (15–49 years) who had given birth at least once and were currently living together with their husbands in the selected study areas. The same selection criteria were applied in previous studies in Bangladesh (see Alam et al. 2018; Biswas et al. 2017). At the last stage of our sampling, around 759 women meeting the criteria were randomly selected using family planning registration records from the local family planning office.

4.3 Selection of study areas

4.3.1 Areas vulnerable to EWEs

The respondents were selected using a multistage sampling technique. Initially, of Bangladesh's seven divisions during the study period, the two divisions with the highest fertility rates (Sylhet at 2.9 and Chittagong at 2.5), which are above replacement and above the national TFR, were selected.

[5] Here, n refers to the desired sample size; z refers to the standard normal variety value; *p* refers to the proportion of the indicator; *q* refers to 1-p; d refers to the degree of accuracy; N refers to the total number of married women. This study assumed 50 per cent as the indicator percentage, a 95 per cent confidence interval for the normal variate value (z=1.96), and a 3 per cent admissible error (d=0.03)

[6] The calculation for determining the sample size using the allocation method is 1/f × total population. Here, f denotes the sampling fraction, which is 3.71. Thereafter, the sample size for all villages was Khankanabad (1/3.71*949) =255; Lamagaon (1/3.71*629) =169; Paschim Patramati (1/3.71*682) =184; and Kazirgaon (1/3.71*633) =171.

We were not able to execute the whole sampling process with a further selection of study areas based on fertility rates since these data are not readily available at the upazila,[7] union,[8] or village[9] levels. Since we are examining how EWEs relate with fertility, for the latter sampling procedures, we relied on the vulnerability of areas to EWEs. Chittagong, being a coastal region, mostly experiences cyclones in comparison with other EWEs, while Sylhet, surrounded by hilly regions, is mostly affected by flash floods. This contrast contributed to the selection of these two areas of high fertility for comparison.

Of the cyclone-prone areas within Chittagong division, Chittagong district has experienced the highest number of cyclones: 32 events from 1900 to 2018, while Sunamganj district in Sylhet's flash-flood-prone areas has experienced a considerable number of flood events with recent severe floods (EM-DAT 2018). Sunamganj district is a frequently studied wetland area that is vulnerable to flash floods that come down suddenly from the hills across the border in India (Ahmed, Haq and Bartiaux 2019; Haq and Ahmed 2017, 2018; Islam and Sado 2000; Kamruzzaman and Shaw 2018).

Next, one *upazila* from each district was selected on the basis on recent EWEs and data in the literature: Banskhali *upazila* in Chittagong district and Tahirpur *upazila* in Sunamganj district. Banskhali *upazila* has a unique geographic position that makes it vulnerable to regular cyclones, tidal surges, and other natural catastrophes. The area was affected by Cyclone Mahasen in 2013, which affected 28 unions (the lowest administrative tier in Bangladesh) in Chittagong district, including 350 people in Banskhali *upazila* (DDM 2014). Local people also said that this *upazila* was among the worst-affected areas during Cyclone Roanu in 2016, with 24 deaths, six of which were in Khankhanabad. Tahirpur *upazila* in Sunamganj district is highly disaster-prone, particularly to flooding (CDMP II 2014).

After selection of the *upazilas*, key informant interviews (KIIs) were held with the respective Upazila Nirbahi Officers (UNO)[10] to select unions within the *upazilas* that are highly vulnerable. KIIs were then held with the chairmen of the selected unions[11] to select highly vulnerable villages within the unions. Lamagaon village and Khankhanabad village were selected from the Tahirpur *upazila* and Banskhali *upazila*, respectively.

[7] The second lowest tier of regional administration in Bangladesh, the upazila, is administratively similar to a district and plays the most crucial role. The core functions of an upazila are coordination of development and administrative activities at the division, district, and upazila levels, maintenance of general and revenue administration, and performance of magistracy (Ahmed 1974).

[8] Unions are the smallest rural administrative and local government units and represent the lowest tier of local government.

[9] In Bangladesh, a village is the smallest territorial and social unit for administrative and representative purposes. Usually one village is designated as a ward and each union is made up of nine villages.

[10] The UNO is the chief executive of an *upazila*, coordinating various central government departments at the *upazila* level, as well as chairperson of the Upazila Disaster Management Committee (UzDMC), coordinating disaster management activities at the *upazila* level.

[11] The union chairman is the administrative chief of a union as well as the chairperson of the Union Disaster Management Committee (UDMC).

4.3.2 Areas not vulnerable to EWEs

For comparison purposes, we selected two villages from two *upazilas* in Sylhet district with the highest fertility that are not vulnerable to frequent EWEs and have not experienced any EWE in the past 10 years. We held a KII with the District Relief and Rehabilitation Officer (DRRO) in Sylhet, which helped in selecting the *upazilas* of Kanaighat and Sylhet Sadar (see Fig. 1). We then held KIIs with the Upazila Nirbahi Officers from each *upazila*. The KIIs helped us select unions – Mogalgaon union from Sylhet Sadar *upazila* and Jinghabari union from Kanaighat *upazila* – in their *upazilas* which had not experienced any recent EWE. KIIs were then held with locally elected union chairmen from Mogalgaon and Jinghabari to select villages which had not experienced any recent EWE. The villages selected were Kazirgaon (Mogalgaon union, Sylhet Sadar *upazila*) and Paschim Patramati (Jinghabari union, Kanaighat *upazila*). NGO workers from the Bangladesh Rural Advancement Committee (BRAC) working in the locality for a very long time told us (in informal discussions) that these villages had rarely experienced floods or cyclones in the last 20 years.

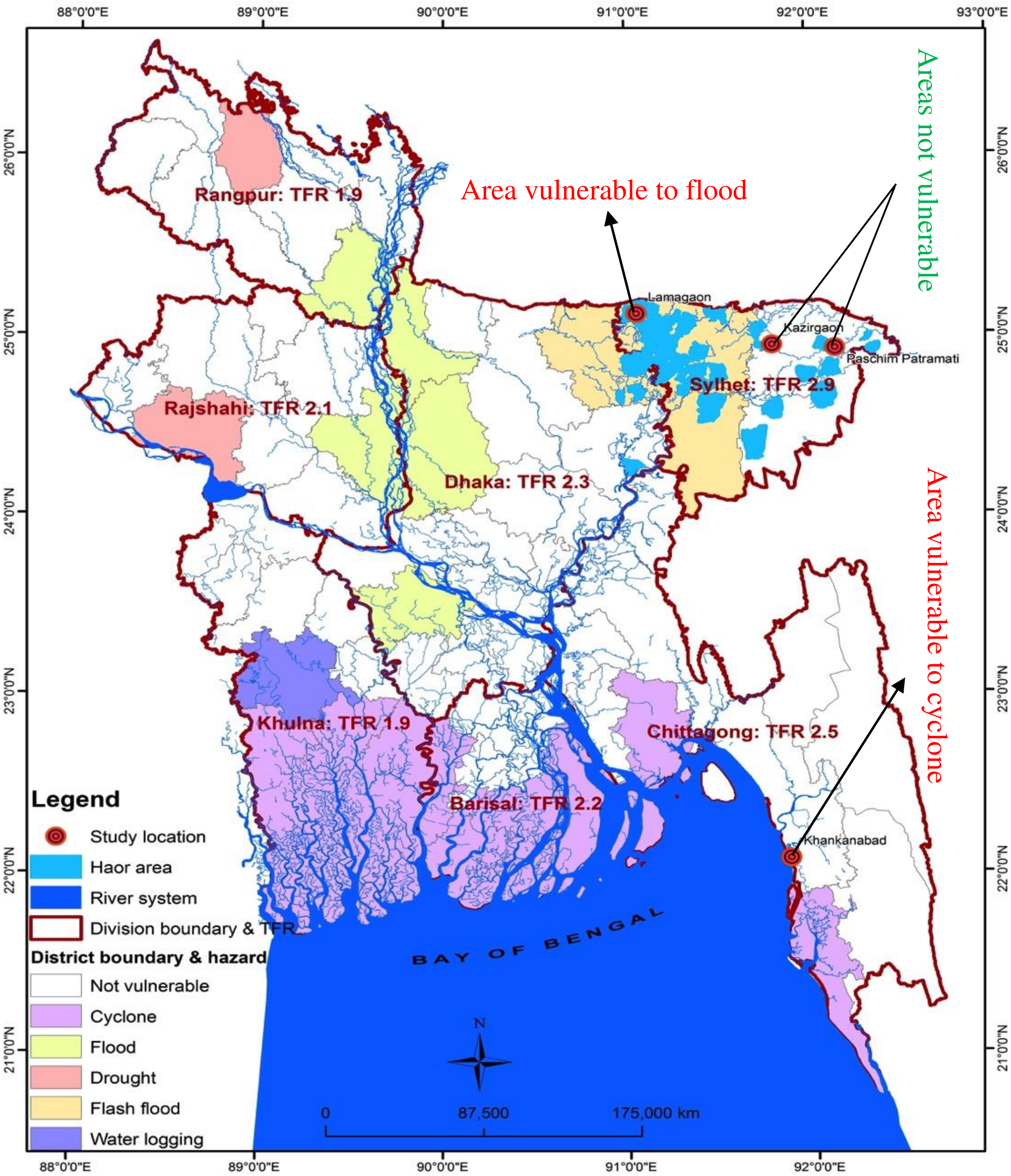
4.4 Data collection techniques

We conducted a questionnaire survey (Appendix B) with our selected ever-married woman to find out their sociodemographic characteristics, household structure, land ownership status and fertility preferences. Respondents were informed about the privacy and confidentiality of the information that would be collected. Participation was voluntary, and written consent was taken before asking the questions. Twenty women refused to participate in the research, thus, no information was collected from them. The respondents were informed about the dissemination of their information through publications. The authors conducted the questionnaires along with eight research assistants (four men and four women) who were master's-level students in social sciences at Shahjalal University of Science and Technology, Sylhet. All the research assistants had good knowledge of the research methodology, were skilled in conducting surveys, and were trained in the data collection procedure before conducting the questionnaire surveys.

4.5 Selected variables and measures

For data analysis, we used descriptive and inferential statistics to examine the association between women's fertility preferences and sociodemographic and risk factors. Binary logistic regression, also used in related studies (Abbawa et al. 2015; Rai et al. 2014; Kipp et al. 2011; Kulkarni and Wali 2015), identified the significant factors that influence women's preference for additional children (Table 1). In the present study, we incorporated two models of binary logistic regression: model **I** includes all of the sociodemographic and risk factors, as mentioned in Table 1; model **II** includes only five factors: age, household type, land ownership, perceived risk of dying, and experience of child mortality. Fertility preference refers to the desire to have additional children in the future (Sasson and Weinreb 2017). Therefore, we considered that the *dependent variable* was *preference for another child*. The responses regarding the women's preference to have another child were grouped and coded

Figure 1. Bangladesh disaster map and study areas



Source: Authors' own

as 1 *if women want to have another child and* responses were grouped and coded as 0 *if women do not want another child.* We also used five categories to know people's fertility intentions: 1. pregnant; 2. intends to have a child within one year; 3. intends to have another child within two years; 4. intends to have another child after a delay of two or more years; 5. intends have another child but undecided as to when. We also asked respondents to answer about their fertility intentions if they do not want another child: 1. undecided; 2. do not want any more children; 3. sterilized (male or female) (Sasson and Weinreb 2017). The following *explanatory variables* (see Table 1) are based on literature from previous studies in many countries: *increased risk of dying* (Sandberg 2006) induces higher fertility preference; *experience of infant/child mortality* (Adhikari 2010; Debral and Malik 2005) is associated with a higher fertility preference; women of a *younger age* tend to prefer more children (Caplescu 2014; Bulto et al. 2014; Rai et al. 2014; Kipp et al. 2011; Abbawa et al. 2015); *household type* prompts various fertility preferences (Aghajanian 2010; Jejeebhoy 1984); *land ownership* is associated with preferences to both have or not have additional children (Shreffler and Dodoo 2009; Behrman 2017; Estudillo et al. 2001; Chege and Susuman 2016); lower *income* households prefer more children (Abbawa et al. 2015); the *education* of women is inversely associated with the preference to have more children (Adhikari 2010; Debral and Malik 2005); those who have *fewer children* want additional children (Caplescu 2014; Rai et al. 2014; Abbawa et al. 2015); those who have a perception of the *ideal number of children* want more children in the future (Adhikari 2010); and *age at first marriage* has a direct effect on higher or lower levels of fertility preference (Adhikari 2010; Debral and Malik 2005).

5. Results

5.1 Socioeconomic and demographic characteristics of respondents

Table 1 presents the sociodemographic characteristics of women surveyed and descriptive statistics of selected variables for the binary logistic regression model. The mean age of respondents is 32.5 and 30.6 years in areas vulnerable and not vulnerable to EWEs. Our study reported fewer respondents aged 15–19 and 45–49 in both areas. Years of schooling is similar in both areas, with half of respondents illiterate. Monthly income is similar in both areas (7141 Bangladeshi Taka [BDT] or 85 USD and 6701 BDT or 79 USD in areas vulnerable and not vulnerable to EWEs, respectively). A significant difference is found with household structure: the majority of households are nuclear in areas vulnerable to EWEs and joint in areas not vulnerable to EWEs. Virtually no difference is observed regarding number of family members. There is no significant variation in land ownership of households. As regards of age at marriage, 74 per cent and 59 per cent from areas vulnerable and not vulnerable to EWEs were married between 15–19 years of age. In addition, the mean age at first marriage in areas vulnerable to EWEs was lower, indicating the presence of early marriage in these areas. The number of living children is 3.5 and 3.1 in areas vulnerable and not vulnerable to EWEs. A major difference is observed regarding the perceived ideal number of children: 3.8 and 2.8 in areas vulnerable and not vulnerable to EWEs respectively. Our study finds that 51 per cent and 36 per cent women from areas vulnerable and not vulnerable to EWEs, respectively, expressed their preference to have another child; these preferences are presented in Table 2.

Table 1 also highlights the descriptive statistics of variables selected for binary logistic regression. It shows that 65 per cent and 88 per cent of women living in areas vulnerable and not vulnerable to EWEs, respectively, had no experience of child death; thus almost three times more women (35%) with child death was reported in areas vulnerable to EWEs than in areas not vulnerable to EWEs (12%). Similarly, more than half of the participants (59%) from areas vulnerable to EWEs perceived a probability of child death, but only 15 per cent in areas not vulnerable to EWEs.

5.2 Perception, experience of child death, and fertility preference

The perception of women regarding the probability of child death is found to be related to their preference for wanting another child (statistically significant for areas vulnerable to EWEs). Table 3 shows that 70 per cent and 46 per cent respondents in areas vulnerable (where it was statistically significant) and not vulnerable to EWEs, respectively, perceived the probability of child death and wanted another child. Similarly, a significant difference in number of living children is observed in both areas between the women who had and had not perceived the probability of child death: women who perceived child death as a probability had a higher mean number of living children (Table 4).

Having an experience of child death is also associated with women's preference for having another child and number of living children (statistically significant for areas vulnerable to EWEs) (see Table 3 and Table 4). With regard to women who had experienced a child death in areas vulnerable and not vulnerable to EWEs, 61 per cent and 51 per cent, respectively, wanted another child. Similarly, a significant difference in number of living children is observed in both areas (though statistically significant only in areas vulnerable to EWEs) between those women who had and had not experienced child death (see Table 4). Table 4 shows the higher mean number of living children for women who experienced child death.

5.3 Relationship between land and fertility

In this study, we found that household ownership of agricultural land is associated with preference to have another child and number of living children. The association is only significant in areas vulnerable to EWEs (see Table 3 and Table 4). Table 3 demonstrates that a majority of women from landless households (61%) in areas vulnerable to EWEs and from the households with land (53%) in areas not vulnerable to EWEs wanted another child. Similarly, Table 4 presents a statistically significant difference regarding the higher number of living children for the landless households compared to households with land in areas vulnerable to EWEs. The difference is, however, not significant in areas not vulnerable to EWEs.

5.4 Household structure and fertility preference

Our study finds that the fertility preference of women varies between nuclear and joint households (see Table 3). A higher proportion of women in nuclear households (56%) in areas vulnerable to EWEs and in joint households (42%) in areas not vulnerable to EWEs wanted another child. This association between household structure and fertility preference is statistically significant only in areas vulnerable to EWEs. Table 4 also shows the mean differences in number of living children, which is significant and higher in nuclear families in both areas. The mean number of living children in nuclear and joint families in areas vulnerable to EWEs is 3.94 and 2.88, respectively ($p<.001$, F 38.89), and in areas not vulnerable to EWEs is 3.34 and 3.01, respectively, where the difference is nearly significant at 5 per cent ($p=.048$, $F=3.93$).

5.5 Association of sociodemographic and risk factors affecting fertility preference

Two binary logistic regression models were performed to examine the effects of sociodemographic and risk factors on the preference to have additional children: model **I** includes all of the sociodemographic and risk factors (Table 5); model **II** (Table 6) considers only five factors: perceived risk of child mortality, experience of child mortality, age of mother, household type, and land ownership.

Binary logistic regression model **I** was statistically significant in both areas (in areas vulnerable to EWEs: λ^2 (11) =369.190, $p<.0001$; in areas not vulnerable to EWEs: λ^2 (11) =106.166, $p<.0001$) (see Table 5), which explains the 80 per cent and 39 per cent variation (Nagelkerke R^2) in areas vulnerable and not vulnerable to EWES, respectively, regarding preference to have additional children. In both areas, five different covariates (two of them – land ownership and age – are common) out of 11 significantly explained fertility preference.

In areas vulnerable to EWEs, two variables – perceived risk of child death and ideal number of children – have a positive association with fertility preference, while land ownership, age, and the number of living children have an inverse relationship with fertility preference. The preference to have another child is 5.5 times higher for women who perceived the probability of child death compared to their counterparts (OR=5.5, 95% CI: 1.90, 15.86). Moreover, the preference to have another child is increased by 9.2 times with increase in the perceived ideal number of children (OR=9.2, 95% CI: 4.9, 17.44). The preference to have another child tends to be higher among women from landless households compared to those from households with land (OR= .37, 95% CI: .15, .89). Finally, and importantly, as women's age and number of living children increase, the desire for more children decreases.

Meanwhile, *in areas not vulnerable to EWEs*, four variables – experience of child mortality, household type, land ownership, and years of schooling – have significant positive associations with an inverse relationship of age of women. In particular, the preference to have another child is around 4.4 times greater for women who have experienced a child death compared to their counterparts (OR=4.38, 95% CI: 1.84, 10.39). Moreover, the preference to have another child is 2.4 times higher for women living in joint families compared to their counterparts in nuclear families (OR=2.44, 95% CI: 1.11, 5.35). The preference to have another child tends to be higher among women from households with agricultural land compared to those in landless households (OR= 3.147, 95% CI: 1.66, 5.96). In addition, women are more likely to have another child as years of schooling increases (OR=1.20, 95% CI: 1.08, 1.34). Nevertheless, as their age increases, women become less likely to want another child (OR=.889, 95% CI: .82, .96).

Similarly, logistic regression model **II** (Table 6) was statistically significant for both areas (in *areas vulnerable to EWEs*: λ^2 (5) =298.397, p<.0001; and *in areas not vulnerable to EWEs*: λ^2 (5) =86.596, p<.0001). The model highlighted a 69 per cent (Nagelkerke R^2) variance in fertility preference in areas affected by EWEs, and 32 per cent in areas not affected by EWEs. In both areas, four of the five covariates (three of them – an experience of child mortality, land ownership, and age – are common) significantly explained the fertility preference.

In areas vulnerable to EWEs, fertility preference is nearly six times higher for women who perceived a risk of child death (OR=5.75, 95% CI: 2.58-12.79). Fertility preference is around 4.3 times higher for women who experienced a child death compared with those who had not (OR=4.27, 95% CI: 1.20, 6.42). As women's age increases, they are less likely to want another child (OR=.670, 95% CI: .61, .72). Preference to have another child tends to be lower among the women from households with land compared to their counterparts (OR= .349, 95% CI: .17, .74).

In areas not vulnerable to EWEs, the preference for additional children is 4.27 times higher for mothers who had experienced the death of a child (OR=4.27, 95% CI: 1.88-9.67) and 2.33 times higher in joint families as opposed to nuclear (OR=2.33, 95% CI: 1.36, 4.10). In addition, fertility preference is 4.27 times higher for households with land compared to landless houesholds (OR=4.27, 95% CI: 2.45, 7.27). As women's age increases, they are less likely to want another child (OR=.839, 95% CI: .79, .88).

6. Discussion

The present study was conducted to understand how selected variables, such as land ownership, household structure and child mortality, influence the fertility preference of women living in areas vulnerable and not vulnerable to EWEs in Bangladesh. Four villages were selected as study areas for this mixed-methods research: two villages (Khankanabad, in a cyclone-prone area, and Lamagaon, in a flood-prone area) grouped as vulnerable to EWEs, and two (Kazirgaon and Paschim Patromati) grouped as not vulnerable to EWEs.

Our analysis reveals that grouped study areas have very similar sociodemographic and economic characteristics. We observed, as we expected, that an experience of child death, a perception of the risk of child death, and fertility preferences are higher in areas vulnerable to EWEs. Our analysis reveals the association of perception of risk of child death and fertility preference, and that of experience of child death and fertility preference, are significant only in areas vulnerable to EWEs. Women who perceive a risk of child death have a higher number of living children, with a statistically significant difference compared to their counterparts, in both areas. The experience of child death has a significantly influence on number of living children only in areas vulnerable to EWEs. This finding is consistent with a great deal of prior research, which confirmed that higher infant mortality is associated with higher fertility preference (Finlay 2009; Yeatman et al. 2013; Sandberg 2006; Kabir et al. 2001; Chen et al. 1974; Choudhury et al. 1976). Differences in fertility preference and in number of living children – in association with experience of child mortality and perception of the risk of child mortality – in areas vulnerable and not vulnerable to EWEs may be a way of taking out 'insurance' against the adverse impacts of natural disasters or risky environments (Cain 1981, 1983, 1986; Frankenberg et al. 2015; Pörtner 2008).

Land ownership of households is significantly associated with fertility preference, which varies for areas vulnerable and not vulnerable to EWEs. Though our findings demonstrate that a majority of women from landless households (61%) in areas vulnerable to EWEs and of women from households with land (53%) in areas not vulnerable to EWEs wanted another child, the association is insignificant in areas not vulnerable to EWEs. A similar association is observed between land ownership and number of living children. Floods and riverbank erosion damage agricultural lands and crops (Ayeb-Karlsson et al. 2016), and such damages brought about by disasters force people to sell off their land and assets (Karim 1995). With changes in households' socioeconomic condition as an adverse effect of EWEs (i.e., loss of land and crops and being forced to sell land) and a scarcity of natural resources, having more children could be beneficial (Aggarwal, Netanyahu and Romano 2001; Filmer and Pritchett 2002; Sasson and Weinreb 2017). We find relatively a higher fertility preference and number of living children among women from households with land in areas not vulnerable to EWEs due to the need to meet agricultural labor demands among poor households (Filmer and Pritchett 2002; Sasson and Weinreb 2017).

Though a higher proportion of women in nuclear households (56%) in areas vulnerable to EWEs and in joint households (42%) in areas not vulnerable to EWEs wanted another child, this association between household structure and fertility preference is statistically significant only in areas vulnerable to EWEs. Regarding the mean differences in number of living children, it is significant and higher in nuclear families in both areas. This finding, especially for areas vulnerable to EWEs, confirms the findings of previous studies conducted in India, Iran, and Pakistan, which conclude that nuclear families have higher fertility (Aghajanian 1978; Durr-E-Nayab 1999; Jejeebhoy 1984). The decreasing trends of joint households may be related to the considerably higher incidence of landlessness (Amin 1998), in our study mainly in areas vulnerable to EWEs. This is because sons in landless households leave their parental home earlier to form their own households than do sons in households with land (Amin 1998; Cain 1978). A nuclear household in areas vulnerable to EWEs where people cannot rely entirely on the land for livelihood due to the adverse effects of EWEs may reasonably prefer more children, especially sons, who can go out and work to earn money through alternative livelihood options (Haq 2013).

Two logistic regression models were performed to examine the effects of sociodemographic and risk factors on the preference to have additional children: model **I** includes 11 sociodemographic and risk factors, while model **II** considers only five of them – perceived risk of child mortality, experience of child mortality, age of mother, household type, and land ownership. For our second model, we kept only variables we thought would be significant.

Binary logistic regression model **I** with 11 covariates and model **II** with five covariates explain a higher variation in fertility preference in areas vulnerable to EWEs compared to areas not vulnerable to EWES. Five different covariates (two of which – land ownership and age – are common) of model **I** in each area and four different covariates (three of which – an experience of child mortality, land ownership and age – are common) of model **II** in each area significantly explained the variation. In model **I**, *in the areas vulnerable to EWEs*, perceived ideal number of children was the most influential covariate, followed by perceived risk of child mortality and land ownership. Meanwhile, *in areas not vulnerable to EWEs*, the experience of child death was the most influential covariate, followed by land ownership and household structure. In model **II**, *in areas vulnerable to EWEs*, perceived risk of child death was the most influential covariate (as it is in the model **I**), followed by the experience of child death and land ownership. *In areas not vulnerable to EWEs*, land ownership was the most influential covariate, followed by the experience of child death and household type. Both models show that the perceived risk of child death and land ownership are common among the most influential covariates in areas vulnerable to EWEs. In contrast, both models show that the experience of child death, land ownership, and household type are common among the most influential covariates explaining the variation in fertility preference in areas not vulnerable to EWEs.

Our study did not incorporate household power dynamics and use of contraceptives in the analysis for explaining the role of women in fertility preferences. Women's empowerment, however, is a significant predictor of fertility control behavior (Alam et al. 2018; Rahman et al. 2014) and health-seeking behavior (Ghose et al. 2017; Mainuddin et al. 2015) in Bangladesh. Kabir et al. (2017) examined the decision-making power of women of reproductive ages through the use of 2014 BDHS data and concluded that women with non-government organization (NGO) membership and who are employed are more empowered. Similarly, NGO membership is found to be a significant predictor in family planning practices in Ghana (Norwood 2011). In rural settings of Bangladesh, NGOs promoted microcredit programs targeting poor women, which play a crucial role and are successful in empowering the targeted group (Amin, Becker and Bayes 1998). During our fieldwork, we noticed several NGOs working in the study areas. Recently, Bangladesh has shown remarkable progress in women's empowerment, attributed to overall development (Chowdhury et al. 2016; Mainuddin et al. 2015). In a study examining the association between women's decision-making autonomy and utilization of maternal healthcare services, Ghose et al. (2017) – using BDHS 2014 data – concluded that decisions regarding women's healthcare, large household purchases, children's healthcare, and visits to family or relatives are mostly made jointly rather than alone by the husband or wife.

7. Conclusions

Our study findings lead us to conclude that fertility preferences vary between areas vulnerable and not vulnerable to EWEs. The factors selected for study may have a different influence simultaneously in the areas selected for comparison. Our final findings from our binary logistic regression analyses show that perceived risk of child death and land ownership are the most influential covariates in areas vulnerable to EWEs. In contrast, the experience of child death, land ownership, and household structure are the most influential covariates explaining variations in fertility preference in areas not vulnerable to EWEs. Since the perception and experience of child death is found to be an influential factor in women's fertility preference, effective measures taken by the government and NGOs within existing family planning or health care programs in Bangladesh could help to address higher fertiltiy. The areas vulnerable to EWEs deserve special attention since the perceived risk of child death is associated with the frequent occurrence of EWEs. We recommend supporting alternative livelihood options through disaster management programs for vulnerable populations living in areas vulnerable to EWEs because, in our study, we found a higher fertility preference and number of children among women in landless households in flood- and cyclone-prone areas.

From a research standpoint, some limitations should be identified in our study. For the multistage sampling, most of the stages relied on the vulnerability to EWEs of various areas, determined through a review of the literature and interviews with local experts. We could not invigorate the selection procedure due to the lack of readily available data on climate variability, natural disasters, and fertility rates at the local union or village levels in Bangladesh. Thus, future research is suggested incorporating a measurement to define the vulnerability of a local area to EWEs. Future research that includes more areas vulnerable to different EWEs (floods, cyclones, droughts, riverbank erosion, etc.) and nearby areas not vulnerable to EWEs could point to strong conclusions regarding the influence of EWEs on fertility preference. Another limitation was that we did not differentiate areas vulnerable to flooding from areas vulnerable to cyclones. This could be addressed in future research to generate a solid understanding of whether fertility preferences vary, and to what extent, between an area vulnerable to an EWE and others. In addition, future research, including high- and low-fertility regions that are also vulnerable to EWEs, may prove to be a fruitful line of investigation. The observation of a higher number of nuclear families could yield more clear results in terms of the effects of EWEs on household structure and its association with changes in fertility preferences. Despite these drawbacks, this study conducted in Bangladesh sought to examine the influence of selected sociodemographic factors on fertility preference in areas vulnerable and not vulnerable to EWEs and provides us with a direction of research at the micro level in the study of links between natural disasters and fertility.

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Appendix A

Table 1. Sociodemographic profile of the respondents and selected variables for binary logistic regression

Sociodemographic characteristics	Description of the selected variables for binary logistic regression	% (N) or Mean (SD)	
		Areas vulnerable to EWEs	Areas not vulnerable to EWEs
Age			
15–19		3.8 (10)	2.9 (10)
20–24		10.8 (46)	15.7 (54)
25–29		17.2 (73)	19.4 (67)
30–34		20.2 (86)	32.2 (111)
35–39		36.7 (156)	20.9 (72)
40–44		8.2 (35)	7.8 (27)
45–49		3.1 (13)	1.2 (4)
Mean[b*]		32.50 (6.22)	30.61 (5.89)
Age at 1st marriage [b,c*]		17.11 (2.19685)	18.20 (1.78574)
Years of schooling [b*]		2.2	1.9
Educational status			
Illiterate		49.9 (212)	55.1 (190)
Literate		8.7 (37)	9.3 (32)
Primary		35.5 (151)	28.4 (98)
Secondary		5.4 (23)	5.5 (19)
Post-secondary		0.5 (2)	1.7 (6)
Household income (monthly) [85 BDT= 1 USD]			
Below 5000		20.2 (86)	30.7 (106)
5001–10000		64.9 (276)	58.3 (201)
10001–15000		14.8 (63)	11 (38)
Mean (SD) [b*]		7141	6701
Type of family [b*]			
Nuclear	0 if the household structure is nuclear; 1 if joint	66 (281)	43.8 (151)
Joint		34 (144)	56.2 (194)
Family size			
2–4		21.7 (92)	21.7 (75)
5–7		40.9 (174)	55.9 (193)
8–10		30.8 (131)	18.3 (63)
11–13		5.9 (25)	1.7 (6)
13+		0.7 (3)	2.3 (8)
Mean (SD) [b*]		6.5	6.1
Land ownership [b*]	0 if a household does not have any agricultural land; 1 if it does		
Landowners		33.6 (143)	35.4 (122)
Non-landowners		66.4 (282)	64.6 (223)
Age at 1st marriage			
15–19		74 (315)	59 (204)
20–24		26 (110)	41 (141)
Distribution of number of children			
1–3		53 (218)	72 (248)
4–6		40 (166)	25 (87)
7–9		3 (12)	3 (10)
10–12		4 (18)	--
Number of living children [b*]		3.5	3.1
Perceived ideal number of children [b*]		3.8	2.8

Preference for additional children[a*]			
No	0 if the women do not want additional children; 1 if otherwise	49 (202)	64 (221)
Yes		51 (212)	36 (124)
Experience of child death [b*]			
No	0 if the women have not experienced a child death; 1 if they have	65 (268)	88 (303)
Yes		35 (146)	12 (42)
Perceived risk of child death [b*]			
No	0 if the women do not perceive the probability of a child death; 1 if they do	41 (170)	85 (295)
Yes		59 (244)	15 (50)

[a] Outcome variable

[b] Explanatory variables

[c] Childbearing outside of marriage is not socially accepted in Bangladesh when marriage also legalizes the cohabitation. Age at first marriage, therefore, has a major effect on childbearing because the risk of pregnancy depends primarily on age at first marriage. In Bangladesh, women who marry early, on average, are more likely to have their first child at a young age and give birth to more children overall, contributing to higher fertility (BDHS 2014).

[*] Variables considered for binary logistic regression

Table 2. Preference for additional children

Opinions on fertility	% (N)	
	Areas vulnerable to EWEs	Areas not vulnerable to EWEs
Prefer additional children Pregnant now	13 (54)	12 (41)
Intent to have another child within one year	8 (31)	6 (20)
Intent to have another child within two years	11 (46)	10 (34)
Intent to have another child after a delay of at least two years	9 (35)	5 (16)
Intent to have another, undecided when	13 (55)	6 (20)
Don't want additional children Undecided	2 (10)	--
Doesn't want more	41 (168)	59 (206)
Sterilized (male or female)	3 (15)	2 (8)
Total (%, N)	100 (414)	100 (345)

Table 3. Relationship between sociodemographic and risk factors and preference for additional children

	Preference for additional children % (N)			
	Areas vulnerable to EWEs*		Areas not vulnerable to EWEs	
	Not prefer	Prefer	Not prefer	Prefer
Perceived risk of child death				
No	76 (128)	24 (41)	66 (194)	34 (101)
Yes	30 (73)	70 (171)	54 (27)	46 (23)
Experience of child death				
No	55 (144)	45 (119)	68 (199)	32 (96)
Yes	39 (57)	61 (89)	49 (20)	51 (21)
Land ownership				
No	39 (107)	61 (168)	73 (164)	27 (57)
Yes	68 (95)	32 (44)	47 (57)	53 (65)
Household type				
Nuclear	44 (120)	56 (154)	72 (109)	28 (42)
Joint	59 (82)	41 (58)	58 (112)	42 (82)

* P value is significant at 5 per cent for all selected variables only for the areas vulnerable to EWEs

Table 4. ANOVA test result on sociodemographic and risk factors and number of living children

	Areas			
	Areas vulnerable to EWEs		Areas not vulnerable to EWEs	
	Mean (SD)	F (p value)	Mean (SD)	F (p value)
Perceived risk of child death				
No	3.05 (1.19)	31.05 (.000)	3.03 (1.37)	11.19 (.001)
Yes	3.9 (1.88)		3.81 (1.98)	
Experience of child death				
No	3.06 (1.45)	80.24 (.000)	3.10 (1.48)	1.99 (.159)
Yes	4.5 (1.69)		3.46 (1.61)	
Land ownership				
No	3.72 (1.79)	5.37 (.021)	3.10 (1.44)	.569 (.451)
Yes	3.31 (1.44)		3.23 (1.60)	
Household type				
Nuclear	3.94 (1.75)	38.89 (.000)	3.34 (1.64)	3.93 (.048)
Joint	2.88 (1.31)		3.01 (1.37)	

Table 5. Key findings of binary logistic regression (full model)

Sociodemographic and risk factors	Areas							
	Areas vulnerable to EWEs				Areas not vulnerable to EWEs			
	P value	Coefficients	Odds ratio (OR)	Confidence interval (CI)	P value	Coefficients	Odds ratio (OR)	Confidence interval (CI)
Perceived risk of child death No® Yes	**.002**	1.705	**5.50**	1.90-15.86	.186	.594	1.812	.75-4.36
Experience of child death No® Yes	.693	.206	1.22	.44-3.41	**.001**	1.477	**4.380**	1.84-10.39
Household type Nuclear® Joint	.306	.700	2.01	.52-7.69	**.025**	.895	**2.447**	1.11-5.35
Land ownership No® Yes	**.027**	-.994	.370	.15-.89	**.000**	1.146	**3.147**	1.66-5.96
Age	**.000**	-.384	.681	.60-.76	**.003**	-.117	.889	.82-.96
Years of schooling	.889	-.011	.989	.84-1.15	**.001**	.190	1.209	1.08-1.34
Household income	.247	.000	1.00	1-1	.988	.000	1.000	1-1
Family size	.977	.007	1.00	.61-1.63	.119	-.119	.888	.76-1.03
Number of children	**.000**	-1.238	.290	.15-.56	.192	-.205	.815	.97-1.71
Perceived ideal number of children	**.000**	2.224	**9.24**	4.9-17.44	.073	.257	1.293	.97-1.71
Age at first marriage	.418	.096	1.10	.87-1.38	.714	-.038	.963	.78-1.18
R square	Cox and Snell 60% Nagelkerke 80%				Cox and Snell 29% Nagelkerke 39%			

® Reference category; DV: Preference to have another child [Reference category "No"]

Table 6. Key findings of binary logistic regression (reduced model)

Sociodemographic and risk factors	Areas							
	Areas vulnerable to EWEs				Areas not vulnerable to EWEs			
	P value	Coefficients	Odds ratio (OR)	Confidence interval (CI)	P value	Coefficients	Odds ratio (OR)	Confidence interval (CI)
Perceived risk of child death No® Yes	**.000**	1.754	**5.75**	2.58-12.79	.068	.673	1.96	.95-3.93
Experience of child death No® Yes	**.017**	.1.453	**4.275**	1.20-6.42	**.000**	1.452	**4.272**	1.88-9.67
Household type Nuclear® Joint	.790	-.062	.940	.42-1.93	**.002**	.849	**2.337**	1.36-4.10
Land ownership No® Yes	**.006**	-1.053	.349	.17-.74	**.000**	1.453	**4.275**	2.45-7.27
Age	**.000**	-.401	.670	.61-.72	**.000**	-.176	.839	.79-.88
R square	Cox and Snell 52% Nagelkerke 69%				Cox and Snell 24% Nagelkerke 32%			

® Reference category; DV: Preference to have another child [Reference category "No"]

Appendix B

Survey Questionnaire

Demographics and household information

1. Study area:
    a) vulnerable to extreme weather events, b) not vulnerable to extreme weather events
2. Age:
3. Age at first marriage:
4. Completed educational status:
    a) illiterate, b) literate, c) primary, d) secondary, e) post-secondary
5. Years of schooling:
6. Household structure:
    a) nuclear, b) joint
7. Number of household members:
8. Household income (monthly):
9. Agricultural land ownership of the household:
    a) yes, b) no

Fertility of women

10. Number of living children:
11. Perceived ideal number of children:
12. Preference to have another child:
    a) yes, b) no
13. If yes, please specify:
    a) pregnant now, b) intent to have another child within one year, c) intent to have another child within two years, d) intent to have another child after a delay of at least two years, e) intent to have another child, undecided when
14. If no, please specify:
    a) undecided, b) do not want more, c) sterilized (either member one of the couple)

Child mortality

15. Do you think there is a probability of child death in the coming days?
    a) yes, b) no
16. Have you experienced any child death?
    a) yes, b) no

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