Legacies of gusts, bloods, and floods: Long-term impacts of the 1970 cyclone in Bangladesh *

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ABSTRACT

We use childhood exposures to disasters as natural experiments inducing variations in adulthood outcomes. Following the *fetal origin* hypothesis, we hypothesize that children from households with greater exposure will have poorer health, schooling, and consumption outcomes. Employing a unique dataset from Bangladesh, we test this hypothesis for the 1970 cyclone that killed over 300,000 people in southern Bangladesh. We find that children surviving the cyclone experience significant health, schooling and consumption adversities, and during their adulthood, have lower probabilities of good health and primary schooling; and lower durations of good health, schooling and consumption. Such adversities are further heightened among the rural and less-educated households. Therefore, public programs benefiting the females and the poor, alongside the development of healthcare and schooling infrastructure, can be useful protective measures against the long-term harms of a disaster.

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Highlights

- The 1970 Bhola cyclone that killed around 300,000 people has some lingering effects on the affected households in Bangladesh.
- There are long-term health, schooling and consumption adversities from in-utero and childhood exposure from the 1970 cyclone.
- Rural households experience heightened adversities, whereas parental education can mitigate some of the adversities.
- Public programs developing schooling and healthcare facilities can provide protection against long-term harms of disasters.

1. Introduction

Poor households from developing countries often lack the means to invest in protection to reduce or avoid risks of, or to insure against possible losses from, disasters. Instead, they frequently adopt coping strategies, such as cutting back on the consumption of food and nutrients or selling productive assets, that adversely affect the human capital development and income-earning potential of children (Almond and Currie 2011; Jensen 2000; Heckman 2007). Therefore, short-term effects of disasters will have long-term lingering impacts especially in developing countries: children from poorer households with greater exposure to disasters will have adverse health, schooling and consumption outcomes that could impact significantly their adult lives.

Exploring these linkages between early childhood developmental impediments and adulthood outcomes requires measuring the long-term impacts of a disaster on the children born and raised during such an event, including potentially lower health, schooling and consumption outcomes when they become older. To date, most studies investigating this "*fetal origin*" hypothesis have focused on high-income countries,[1] although there are growing number of studies for developing countries (e.g., Akresh, Halim, and Kleemans 2018; Currie and Vogl 2013; Petrou and Kupek 2010; Razzaque *et al.* 1990). To shed further light on this possible relationship, we investigate the long-term health, schooling and consumption impacts of the 1970 cyclone that killed around 0.3 million people in southern coastal regions of Bangladesh, which is among the deadliest disasters in modern history.

Following existing literature, we hypothesize that children from households with greater exposure to the 1970 cyclone, measured in terms of birth cohorts and birthplaces, will have lower health, schooling and consumption outcomes. Using the Bangladesh Household Income and Expenditure Survey (HIES) dataset, we employ a difference-in-difference method empirically to investigate these long-term effects for regions and cohorts with different degrees of exposure.

We make a number of novel contributions. First, this paper adds to the growing literature on early-life shocks and later-life outcomes for developing countries, which is important given that developing countries experience more frequent disasters.

Second, Bangladesh is among the most vulnerable countries to the risk of disasters with a long history of devastating tropical storms and floods (Table A.1). While there have been studies of the

[1] See Currie (2009), Almond and Currie (2011), and Almond, Currie, and Duque (2018) for comprehensive reviews.

immediate impacts of the 1970 cyclone (e.g., Sommer and Mosley 1972), our paper is the first to investigate their long-term impacts across different regions of Bangladesh. To our knowledge, Razzaque *et al.* (1990) is the only other study that examines the long-term effects, but for the 1974 famine and only for a specific region of Bangladesh. By focusing on differential regional exposure to specific adverse events with considerable immediate and long-term consequences, this paper makes an important contribution to understanding the economic impacts to households across Bangladesh from such threats.

Third, we make a unique contribution to this literature by separating the net impacts of the 1970 cyclone from other contemporary adverse events, i.e., the 1971 war and the 1974 famine. Since multiple adverse events at different stages of childhood can have confounding effects on the long-term outcomes (Almond and Currie 2011; Heckman 2007), we control for these potential cross-effects from these overlapping events to identify the net long-term effects of the 1970 cyclone. This is important for developing countries, such as Bangladesh, which are likely to experience more frequent disasters – as well as disasters mixed in with adverse political events – in coming years.

Finally, several important policy implications emerge from our analysis. Our results indicate that the rural poor households experience heightened long-term adversities from their childhood exposure to a disaster, whereas schooling has mitigating effects on these outcomes. Therefore, government investments targeted at benefiting the rural poor, such as educational and infrastructural development programs, might have remedial influences on the harms of a disaster. This further confirms the long-term benificial effects of publicly funded projects, such as food-for-education, school meal programs and female secondary school scholarships, as well as social safety net and food-for-work programs to support the extreme poor.[2]

2. Background and literature

2.1. Literature

Medical evidence indicates that poor environmental conditions during the prenatal and neonatal periods have adverse consequences on an individual's life expectancy, height, cognitive ability, and

[2] For example, Singh, Park, and Dercon (2014) find that school meals can significantly ameliorate the deterioration of health of young children of the drought affected families in Indian state of Andhra Pradesh.

productivity (Barker 1990; Barker 1992). This "*fetal origin*" hypothesis, which is extensively investigated in epidemiology and public health literature, receives considerable empirical attention in economics as well (Almond and Currie, 2011; Almond, Currie, and Duque 2018).

The related economics literature has examined various types of extreme events taking place during the prenatal, neonatal and early childhood periods. Examples of such events with profound adverse impacts on children in the long-term include wars and conflicts (Akresh, Lucchetti, and Thirumurthy 2012; Bundervoet, Verwimp, and Akresh 2009; Kesternich *et al.* 2014; Lee 2014), economic cycles (Banerjee *et al.* 2010; Cutler, Miller, and Norton 2007; Thomasson and Fishback 2014; Van Den Berg, Lindeboom, and Portrait 2006; Yeung *et al.* 2014), disease outbreak (Cutler *et al.* 2010; Lin and Liu 2014; Venkataramani 2012), tropical storms (Sotomayor 2013), radiation fallout (Almond, Edlund, and Palme 2009) and rainfall (Maccini and Yang 2009).

Early life exposure to civil wars and conflicts may result in lower health, schooling and labor market outcomes in the long-term (Akresh, Lucchetti, and Thirumurthy 2012; Bundervoet, Verwimp, and Akresh 2009; Kesternich *et al.* 2014; Lee 2014). Sotomayor (2013) showed that individuals in the womb or early infancy in the aftermath of the 1928 and 1932 tropical storms in Puerto Rico were more likely to contract hypertension, high cholesterol and diabetes, and were considerably more likely to have no formal schooling. Neelsen and Stratman (2011) found that infants during the 1941-42 famine in Greece had significantly lower schooling and labor market outcomes in their adulthood, with stronger impacts for urban cohorts. Chen and Zhou (2007) indicated that the 1959-61 famine in China caused serious health and economic consequences for the survivors, especially for those in early childhood during the famine. Almond, Edlund, and Palme (2009) showed that the radiation spread due to the 1986 Chernobyl nuclear accident in Ukraine resulted in adverse schooling and income impacts, but no health impacts, in Sweden. Field, Robles, and Torero (2009) revealed that the prenatal iodine supplementation raised educational attainment by half a year of schooling in Tanzania, with larger impacts for girls. In addition, Maccini and Yang (2009) found that the long-term well-being of Indonesian women was highly sensitive to their early-life environmental conditions. Likewise, higher early-life rainfall had positive effects on adult outcomes for women, but not men, which may reflect gender biases in household resource allocation.

2.2. Timeline

Geographic location and land characteristics make Bangladesh among the most disaster-prone countries in the world: 26% of the population are affected by cyclones and 70% live in flood-prone regions (Cash *et al*. 2014). Widescale flooding has been the most recurrent type of disaster striking Bangladesh, and the country remains one of the worst sufferers of cyclonic casualties in the world. Table A.1 provides a historical summary of disasters, by subtypes as defined by EM-DAT (2020), which took place in Bangladesh (formerly East Pakistan) during 1900-2019. In addition, Bangladesh was born out of conflict; it became an independent country in 1971 following nine months of war with the Pakistani army that resulted in possibly 3 million lives lost (Rummel 1997).

[Table 1]

Consequently, the 1970-1974 period, which includes the 1970 cyclone, the 1971 war and the 1974 famine (Table 1), is exceptional even for Bangladesh due to the extent of severity both in terms of number of casualties and monetary losses (see van Schendel (2009) for details).

The series of 1970-1974 deadly events started in November 1970 when the "*Great Bhola Cyclone of 1970*", "the 1970 cyclone" for short, struck the coastal regions of Bangladesh (*then* East Pakistan). It formed over the central Bay of Bengal on November 8, 1970, and then intensified while traveling north towards the coasts of Bangladesh and India. It reached the peak with winds of 115 miles per hour on November 11 and made landfall on the coast of Bangladesh the following afternoon.

Considered one of the worst disasters in modern times, the 1970 cyclone resulted in widespread loss of life and property (Sommer and Mosley 1972). The center of the cyclone was Tazumuddin subdivision, Barisal, where the destruction reached the maximum: nearly 47% of the total population died, and all the standing rice crops were destroyed. In general, the 1970 cyclone severely affected the coastal regions of Noakhali and Barisal (Sommer and Mosley 1972).[3] Altogether, around 35% of the rice crops were destroyed in Barisal (Figure 1), and all the coastal and neighboring regions were severely affected. Total mortality was more than 300,000 people, and nearly four million people were directly affected. The estimated total damage was $86.4 million in 1970 U.S. Dollars, equivalent to $450 million in 2006 (EM-DAT 2020; Peduzzi *et al.* 2012). The mean mortality rate throughout the

[3] Regions, as defined in this paper, correspond to former districts that are formed of several current districts. For example, Noakhali region includes the districts of Noakhali, Feni and Lakshmipur; Chittagong region includes Chittagong and Cox's Bazar; Barisal region includes Barguna, Barisal, Bhola, Jhalkathi, Patuakhali and Pirojpur.

affected regions was 16.5%, and over 0.15 million people relied upon aid for half of their food even three months after the cyclone (Sommer and Mosley 1972).

The insufficiency of the relief efforts by the central government of Pakistan created widespread dissatisfaction among the people of East Pakistan and resulted in the resurgence of Bengali Nationalism. The Awami League, the largest political party in East Pakistan, won in the national elections of 1970. This outcome led to the war and eventual independence of Bangladesh in 1971, but resulted in the killing of millions of Bengali civilians.

Bangladesh was facing serious challenges in its early-independence days to tackle the increased prices of essential commodities, which were directly hurting the people. The situation became worse when the famine struck the northern regions of Rangpur and Mymensingh in 1974. The 1974 famine was associated with the severe monsoon floods that came during June to September of 1974 on an inflated Brahmaputra River (Sen 1981). A significant amount of crop was damaged, which led to a further escalation of rice prices, a spike in unemployment and reduced purchasing power (Razzaque *et al.* 1990; Sen 1981). Market failures and price speculation in the food-grains market also played a substantial role in the cause of the famine (Ravallion 1985). Altogether, the 1974 famine caused an estimated 0.45–1.5 million deaths through starvation and diseases such as cholera and diarrhea (Alamgir 1980).

3. Empirical strategy

3.1. Disaster cohorts and regions

The fetal origin hypothesis suggests a causal relationship between health in-utero and adulthood health outcomes (e.g., Barker 1990). Later investigations reveal that the long-term effects of fetal adversities further translated into lower educational attainment, employment opportunities and income (e.g., Case *et al.* 2002; Almond 2006; Walker *et al.* 2007). Moreover, early childhood, instead of in-utero, exposure to such adversities also results in negative long-term consequences. Comprehensive reviews of medical evidence from selected developing countries by Walker *et al.* (2007) and Victoria *et al.* (2008) show that early childhood in addition to in-utero exposure can result in later life lower health, schooling and consumption outcomes.

Therefore, the physical and cognitive developments of children can be affected by inequalities experienced prenatally and in the first year of life (e.g., Neelsen and Stratman 2011; Almond, Currie, and Duque 2018; Walker *et al.* 2011). Consistently, we include newborns during a disaster as well as newborns one year before and after the disaster in the affected cohorts. That is, newborns during 1969-71, 1970-72 and 1973-75, respectively, form the treatment cohorts for the 1970 cyclone, 1971 war and 1974 famine. However, unlike Neelsen and Stratman (2011) for Greece and Caruso and Miller (2015) for Peru who used large census datasets and were able to identify separate adverse effects for individual ages, we instead use age group as the common affected cohort due to small sample size.

Figure 1 supports our classification of cohorts. Panel A shows the number of casualties ('000 deaths) from storms and floods in Bangladesh during 1964-1980 that are reported in EM-DAT database (EM-DAT 2020). Clearly, the 1970 cyclone stands out – around 300 thousand people died in 1970 whereas the next highest number of deaths occurred in 1974 when the famine took place. Damages from such deadly events have also been reflected in rice yield (ton/acre) figures: Panel B shows that Bangladesh has experienced relatively low rice production per acre in 1970 and 1971 (BBS (various years)).

[Figure 1]

Based on historical evidence on the immediate effects of the series of 1970-74 deadly events (e.g., Sen 1981; Sommer and Mosley 1972), we classify Bangladesh into regional groups as detailed in Table 1. Although the 1971 war affected all the regions of Bangladesh, data on regional variations in the severity of the war are not available. Similarly, although the 1974 famine primarily affected the northern regions of Rangpur, Mymensingh, Bogra and Pabna, the entire country was ultimately affected (e.g., Razzaque *et al.* 1990). Therefore, we do not classify any war or famine regions and rather control for the cross-effects on war and famine cohorts from other contemporary shocks in the econometric specification.

Classification of cyclone regions is straightforward, as mapped in Panels C and D in Figure 1. Based on our discussion in section 2.2, we include severely cyclone affected coastal regions of Barisal and Noakhali in the treatment regions (cyclone region 2, R_2). In addition, neighboring regions of Faridpur (to the north of Barisal along the bank of river Meghna) and Khulna (to the west of Barisal along the coast of Bay of Bengal) were mildly affected in terms of damaged crops and properties. We include them in a separate group (cyclone region 1, R_1). Finally, our control regions R_0 include Jessore and Rajshahi regions who experienced similar rice production before and after the cyclone as the R_2 regions, but did not experience similar damages during the 1970 cyclone (Panel D).

3.2. Identification strategy

We exploit the variations in timing and geography (Table 1 and Figure 1) of the 1970 cyclone. For the outcome variable y, the long-term impacts can be estimated by

$$(1) \qquad y_i = \alpha_0 + \theta C + \sum_{j=1}^{2} \vartheta_j R_j + \sum_{j=1}^{2} \beta_j \times \left(R_j \times C\right) + x_i'\delta + \tau_{yob} + \Delta_{pob} + H_{yos} + \epsilon_i,$$

for a household i from the cyclonce region $j = 0,1,2$. In particular, R_j and C denote the cyclone regions and cohorts, respectively. We expect greater exposure to result in greater long-term adversities. Therefore, we interact region dummies R_j and with cohort dummy C which yields the parameter of interest $\beta_j, j = 1,2$. The vector of controls, x', includes household and regional level variables. In addition, τ_{yob}, Δ_{pob} and H_{yos}, respectively, represent the vectors of birthyear, birthplace (i.e., subdivision) and survey year indicators.

However, longer durations of disasters or conflicts, or consecutive events spanning over multiple years such as in our case of 1970-74 series of deadly events in Bangladesh, may result into confounding effects; and, therefore, may bias the estimation by influencing positive selection into fertility (Almond 2006; Neelsen and Stratman 2011). We control for parental schooling to resolve this issue.[4] We also exclude the regions directly affected by the 1974 famine from our classification of cyclone regions. Moreover, it is necessary to control for cross-effects of the 1971 war and 1974 famine on the people from cyclone affected regions when estimating the long-term effects of the 1970 cyclone.

Next, since HIES does not report birthplaces, we assume that the respondents were born in their current location. To reduce the possible discrepency between birthplace and current location, we first exclude the densely populated and highly urban Dhaka and Chittagong and the population-scarce and mountainous Chittagong Hill Tracts (CHT) regions, who are qualitatively different than other regions of Bangladesh. These regions have very high proportion of out-of-district populations. For example,

[4] Section 6.2 further addresses this issue.

within the Dhaka region, highly urban Dhaka, Gazipur and Narayanganj districts have in-district populations of only 49.20%, 59.1%, and 75.8%, respectively.

Moreover, we limit our estimating samples to the agricultural households, who are historically less likely to permanently migrate in order to keep possession of their agricultural lands (BBS 2011).[5] However, limiting the estimating sample only to agricultural households creates the sample selection bias. We use Heckman selection models to correct this problem, by using agricultural landholding, i.e., decimals of agricultural land owned by the household, to select the agricultural sample.[6]

The final specification estimating the long-term effects of the 1970 cyclone, controlling for the cross-effects of other contemporary events and incorporating the selection into agriculture, is

$$(2) \quad y_i = \alpha_0 + \theta C + \sum_k \theta_k C_k + \sum_{j=1}^{2} \vartheta_j R_j + \sum_{j=1}^{2} \beta_j \times (R_j \times C) + \sum_k \sum_{j=1}^{2} \gamma_{jk} \times (R_j \times C_k) + x'\delta + \tau_{yob} + \Delta_{pob} + H_{yos} + \epsilon_i,$$

if i is an agricultural household. R_j and C denote the cyclone regions and cohorts, respectively. Index $j = 0,1,2$ refers to regional groups: $j = 0$ denotes the control regions, whereas $j = 1$ and $j = 2$, respectively, denote mildly affected neighboring regions and severely affected regions. In addition, index $k = war, famine$ refers to other 1970-74 deadly events.

Our β_j parameters of interest come from the interaction $(R_j \times C)\ \forall j = 1,2$ and estimate the net effects of the cyclone on the affected cohort C from region R_j. In addition, parameters $\gamma_{jk}\ \forall j, k$ that come from the interaction $(R_j \times C_k)$ account for the cross-effects of the 1971 war and 1974 famine ($k = war, famine$) on the cyclone-affected regions. Parameters θ and $\theta_k\ \forall k$ estimate the cohort-specific effects, and $\vartheta_j\ \forall j = 1,2$ estimate the region-specific effects.

Within a cohort, long-term effects of cyclone exposure should be common to all households and individuals born in the same locality (e.g., Almond, Edlund, and Palme 2009; Maccini and Yang 2009).

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[5] According to the 2011 Population and Housing Census of Bangladesh (BBS 2011), more than 90% of Bangladeshi people live within their district of birth, with only 4.20% embarking on rural-rural and 4.29% on rural-urban migration. Consistent with Sommer and Mosley (1972) who found that the people from Bhola did not out-migrate even after the 1970 cyclone and instead in-migrated to the affected areas to help their destituted families and relatives, Barisal and Noakhali regions have 93.5%-99.0% and 95.4%-98.2% in-district populations, respectively.

[6] Landholding is the most important determinant of becoming an agricultural household which is excluded from the vector of controls in equations (1) and (2).

Therefore, variations in children's adulthood outcomes resulting from the variations in their time and place of birth should be absorbed by the full set of birthyear (τ_{yob}) and birthplace (Δ_{pob}) fixed effects. In particular, τ_{yob} controls for all other year-specific influences on children's adulthood outcomes, whereas, Δ_{pob} controls for persistent effects of cyclone exposure on the regions and households where the children are born. Finally, since data comes from three different survey years, we include a vector of survey year indicators, H_{yos}, to control for any variations in adulthood outcomes specific to survey year. These fixed effects will control for unobserved time-varying factors that are common across all the regions or subgroups of regions.

Parameters $\beta_j, j = 1,2$ allow for differential effects of regions on cyclone cohorts and we hypothesize that $\hat{\beta}_2 < \hat{\beta}_1 < 0$. These parameters measure the extent of regional variations in outcomes, controlling for all the permanent differences between treatment and control regions.

We assume that

$$(3) \qquad cov(\epsilon_i, R_{jl} \times C_l | C_k, R_{jl} \times C_k, x', \Delta_{pob}, H_{yos}) = 0, \forall j = 1,2 \; and \; k \neq l.$$

That is, our identifying assumption is the independence between the disturbances and the measure of exposure to the 1970 cyclone, conditional on permanent differences between the districts of birth and other control variables. However, $\epsilon_i = \eta_{id} + u_i$, where u_i is the white noise error term, but η_{id} may be correlated across i within d. We cluster the standard errors at the district level to overcome this problem.[7]

3.3. Data and variables

Outcome and household-level control variables come from the Household Income and Expenditure Survey (HIES), which is the principal source of household-level socio-economic data in Bangladesh (BBS 2010). Major components of HIES include, among others, the data on household expenditure, income, consumption, education, and health. We use HIES datasets from the survey years 2000, 2005 and 2010, with corresponding sample sizes of 7,440, 10,080 and 11,240, respectively. We restrict the summary statistics of the variables, as detailed in Table 2, to disaster regions and birth cohorts as identified in Table 1.

[7] We cluster our standard errors at the district level, which is a larger administrative unit than the thana (i.e., subdivision), to allow for correlation in the error terms of observations within the same thana.

[Table 2]

HIES contains data on the incidence and duration of (chronic) illness. Surveyed individuals self-report whether they suffer from any chronic illness in the previous year. Common examples of such illnesses include injuries, disabilities, chronic heart disease, breathing problem, chronic dysentery, ulcers, blood pressure, arthritis, rheumatism, eczema, diabetes, cancer, leprosy, paralysis, and hysteria. We define the first health outcome variable, *Healthy*, as 1 if an individual does not suffer from any such illness (i.e., good health), and 0 if the individual suffers (i.e., ill health). In addition to this discrete indicator, HIES reports the lifetime duration of illness of an individual. We extract the second health outcome variable, *Ln(Health)*, as the log of an individual's total life-years without any chronic illness.

We use two indicators of schooling outcomes. "*Educated*" refers to 1 if an individual completes at least the 5th grade (i.e., educated) and 0 if not (i.e., uneducated). In addition, we extract the continuous schooling outcome variable, *Ln(Schooling)*, as the log of an individual's total years of schooling.

Two indicators of consumption outcomes are solvency status and per-capita consumption expenditure. We define "*Solvent*" as 1 if a household spends on or above the national average per-capita expenditure (i.e., solvent or non-poor) and 0 if otherwise (i.e., insolvent or poor). In addition, the continuous measure of expenditure, *Ln(Expenditure)*, is the log of per-capita consumption expenditure of a household.

x' is a vector of controls for current household characteristics, and labor market conditions during the birthyear to control for selection into fertility (Almond, Edlund, and Palme 2009). Measures of household characteristics are age, gender, location, and parental schooling. We define "*gender*" as 1 if the household head is a male and 0 if otherwise, "*location*" as 1 if the household lives in a rural area and 0 if otherwise, and "*parental schooling*" as 1 if at least one of the parents completes at least 5th grade (i.e., educated parents) and 0 if otherwise (i.e., uneducated parents). In addition, we use "*ALF*" (i.e., percentage of labor force employed in agriculture during the birthyear) as a measure of regional labor market conditions and its dependency on agriculture during the birthyear. Data on regional controls come from the Statistical Yearbook of Bangladesh (BBS, various years) and the Population and Housing Census of Bangladesh (BBS 2011).

4. Results and discussions

Table 3 confirms that outcome variables do not significantly vary between cyclone regions when untreated (i.e., over the years 1964-1968 and 1972-1980). Therefore, our selection of treatment and control groups for the 1970 cyclone is reasonable (e.g., Mora and Reggio 2015).

[Table 3]

[Figure 2]

Figure 2 plots the outcome variables used in regression analysis for birthyears 1964-1980 for three cyclone regions. Overall, figures confirm that cyclone cohorts from severely cyclone affected regions experience greater variabilities in their outcomes than other cohorts from other regions.

Table 4 reports our main results from estimating equation (2). The estimated directions of relationship are consistent, and complete results in Table A.3 show that the specification (1) underestimates the adversities of cyclone exposure. The 1971 war and the 1974 famine yield some, although mostly insignificant, cross-effects on the long-term effects of the 1970 cyclone. Therefore, controlling for these cross-effects is important for more robust estimates of long-term adversities.

[Table 4]

Results confirm that $\hat{\beta}_2 < 0$ for the health and schooling outcomes, and all the estimated effects are statistically significant. Therefore, we identify significant long-term health and schooling adversities for the 1969-71 cohorts from Barisal and Noakhali regions from their severe exposure to the 1970 cyclone, which are consistent with a set of related literature (e.g., Sotomayor 2013). In particular, when compared to the control cohorts from the control regions, 1969-71 cohorts from severely affected regions have 14.9 percentage points lower probability of good health during their adulthood and 53.6% lower duration of good health over their entire lifetime. They also have 21.8 percentage points lower probability of completing at least 5th grade of schooling and 49% lower years of schooling. Similarly, they have 12.5 percentage points lower probability of solvency and 26.5% lower per-capita expenditure.

However, the signs of $\hat{\beta}_1$ are uncertain and the estimated effects are statistically insignificant for all the regressions. That is, we do not identify any significant long-term adversities for the cyclone cohorts from neighboring regions from their mild exposure to the 1970 cyclone.

These results standout albeit few social and natural remedies. First, the surprising phenomenon of in-migration of extended family members to provide mental and financial supports to the cyclone survivors potentially lowers the long-term adversities (Sommer and Mosley 1972). Second, production of rice went back to the normal levels in Barisal and Noakhali immediately after the cyclone (Figure 1). Together, in-migration and regular harvests, that have been controlled for through the inclusion of R_j and C in the set of control variables, might have some further unobserved mitigating influences on the variations in the long-term outcomes. Rather, our findings confirm that such measures, while important as immediate coping strategies (e.g., Sommer and Mosley 1972), were not able to eliminate the long-term adversities of the 1970 cyclone.

5. Exogenous remediators

Regressions based on specification (2) includes the vector of controls x_i' that includes, among others, the location and parental schooling status (see supplementary Table A.3). These factors can act as exogenous remediators that can at least partially ameliorate the adversities arising from exposure to a disaster.

We therefore extend the empirical specification (2) by including additional interactions for these potential external remediators to see how the long-term effects are either aggravated or mitigated by them:

$$(4) \quad y_i = \alpha_0 + \theta C + +\theta_E \times (C \times E) + \sum_k \theta_k C_k + \sum_{j=1}^{2} \vartheta_j R_j + \sum_{j=1}^{2} \vartheta_{jE} \times (R_j \times E) + \sum_{j=1}^{2} \beta_j \times (R_j \times C) + \sum_{j=1}^{2} \beta_{jE} \times (R_j \times C \times E) + \sum_k \sum_{j=1}^{2} \gamma_{jk} \times (R_j \times C_k) + x'\delta + \tau_{yob} + \Delta_{pob} + H_{yos} + \epsilon_i,$$

if i is an agricultural household. E denotes an external mediator. All other notations remain the same as in equations (1)-(3). Our parameters of interest in equation (4) are $\beta_{jE} \forall E \; and \; \forall j = 1,2$. Table 5 reports $\hat{\beta}_{jE}$, whereas supplementary Tables A.4 and A.5 report detailed results. Outcome variables follow the definitions in Table 2. Shock regions and cohorts follow the definitions from Table 1.

[Table 5]

5.1. Rural-urban variations

Location, defined as 1 if rural and 0 if urban, is an indirect but robust measure of the availability of amenities in a locality. Although such a definition is mostly statistical, as an "urban" household often operates its agricultural lands in an adjacent "rural" area, most health, schooling and employment facilities are available in better quantity and quality in urban areas. Consistently, rural households have lower health, schooling and consumption outcomes (Supplementary Table A.3).

Although health variations are statistically insignificant, rural household heads born during 1969-71 in severely affected regions have 60.8 percentage points lower probability of completing at least 5th grade of schooling. Moreover, their urban counterparts also have 117% higher years of schooling (Table 5). However, health and consumption outcomes do not exhibit any rural-specific heightened adversities. Detailed results are appended in Table A.4.

Such additional adversities experienced by rural households shed light on the importance of infrastructural development as an adaptation policy. Absence of adequate healthcare and schooling facilities deprives the disaster-hit rural people from meeting their basic needs, and affects the long-term welfare of their children. On the contrary, urban areas are less susceptible to the effects of a disaster mostly due to better availability of facilities and better connectivity with the capital city of Dhaka from where all the post-disaster management and rehabilitation programs are usually run.

5.2. Parental education

Although households with educated parents have higher health and educational outcomes and significantly higher consumption expenditure (Table A.3), we do not identify any significant mitigating effect of parental education (Table 5, see Table A.5 for detail results). This is mostly because only 6% of the household heads have educated parents, i.e., at least one of the parents completing at least 5th grade (Table 3). Nevertheless, literature identifies parental education as an important component of any integrated approach to mitigating the long-term adversities of extreme events, especially in developing and less-developed countries. Education increases income (e.g., Mincer 1974), and therefore enabling parents to invest on children that will eventually ameliorate, at least partially, the adverse effects of early childhood disaster exposure (e.g., Adhvaryu, Fenske, and Nyshadham 2019;

Dasgupta 2017). Moreover, Cunha and Heckman (2008) find that early childhood interventions or investments are more important for children's cognitive development, implying that disaster-induced reductions will have detrimental effects on their adulthood educational outcomes. Among the Tigrai-Ethiopian families exposed to famines and civil wars during 1973-1991, Kiros and Hogan (2001) found significant variations in child mortality by parental education; and, therefore, concluded parental education as an important policy intervention in reducing the harms of famines and wars.

6. Robustness check

6.1. Selective mortality

Exposure to disasters is fatal to *in utero* fetus and newborn infants (Walker *et al.* 2011), which may result in selective mortality of inherently weak newborns (e.g., Sanders 2012). If such selection is sufficiently strong, then the survived cohort born in the treatment years may even become healthier compared to the control cohorts. Such selections, if exist, will make the estimated effects relatively conservative since the perished newborns are not present in the treatment cohort anymore. The consequent downward bias will necessarily imply that our estimates could be the lower bound of the true effect.

We run quantile regressions on 25th and 75th percentiles for *Ln(Health)* with the underlying assumption that the stronger newborns who survived the deadly event will belong to higher percentiles and will not have lower health outcomes than the treatment groups. Therefore, there will be considerable differences in estimated effects of exposure for 25th and 75th percentiles regressions.

[Table 6]

However, unlike Pitt and Rosenzweig (1989) who identify the impact of mortality selection even for relatively higher mortality populations, we do not identify any such systematic selective mortality: estimated coefficients for both the regressions are statistically insignificant (Table 6).

6.2. Selective fertility

Widescale disasters often make messy natural experiments, in part because fertility may respond to food shortages and disasters (Dyson 1991; Currie and Rossin-Slater 2013). To verify that our results are not being driven by selection into fertility, we investigate how exposure to these events may have affected fertility. In presence of selective fertility, there will be significantly lower number of newborns in disaster years than in non-disaster years in affected regions.

To check this, we collapse to the district-birthyear level and count the total number of children born in a particular year in each locality. We then use this district-birthyear panel to regress total number of children born in that year on exposure to disaster. Results in Table 7 confirm that neither of the exposure coefficients are significant, offering no evidence of selective fertility or selective child mortality. However, despite their statistical insignificance, estimated coefficients are quite large especially for region-level estimates due to smaller sample size.

[Table 7]

Moreover, since education has a causal protective effect on health and mortality (Lleras-Muney, 2005; Conti, Heckman, and Urzua 2010; Van Kippersluis *et al.* 2010; Galama and Van Kippersluis 2019), there can be selection by parental schooling background, which can drive the health and schooling outcomes of the treatment cohorts and may lead to upward bias in our estimated effects.

We control for parental schooling in all our regressions to deal with this potential selection bias. We also check regression results without controlling for parental schooling to identify how much heavy lifting is required by this control (Freedman 1991). We then consider parental schooling as the outcome variable in a falsification test to check whether there is a bias arising from selective parental schooling (Angrist and Pischke 2009). Results in Table 7 confirm that parental schooling does not respond to exposure to the 1970 cyclone and, therefore, does not cause any selection bias.

6.3. Placebo falsification test

We perform a falsification test by repeating the analysis using only individuals born during 1977-83 in the treatment cohorts, who were never been exposed to any of the 1970-74 deadly events during their respective childhood. We shift the actual treatment cohorts by 8 years so that the placebo cohorts become:

	Placebo cohorts for		
	1970 cyclone	1971 war	1974 famine
Treatment cohorts	1977-79	1978-80	1981-83
Control cohorts	1958-63 and 1980-92	1958-63 and 1981-92	1958-63 and 1984-92

We then rematch the actual affected regions to generate our placebo variable. Estimated coefficients of importance are reported in Table 8, with detail results are appended in Table A.8.

[Table 8]

Results show that placebo treatment groups do not experience any significant long-term health, education, or consumption adversities, confirming that the results in Table 4 are not driven by unobserved time-persistent regional heterogeneity connected with exposure to the 1970 cyclone. Since the placebo treatment cohorts are younger than actual treatment cohorts and placebo control cohorts are predominantly older than actual control cohorts, placebo results unsurprisingly show that the placebo treatment group has better health, education, and consumption outcomes.

7. Conclusion

Controlling for the potential confounding effects of other contemporary disasters, we separate out the long-term impacts of the 1970 cyclone in Bangladesh on the cohorts born and raised during the cyclone in the cyclone affected regions in comparison to control cohorts born and raised in other years in control regions. We identify that the 1969-71 cohorts from the severely affected regions have significantly lower health, schooling, and consumption outcomes. In addition to the overall adversities the cyclone-affected regions experience, rural and less-educated households are more vulnerable to the exposure to any disaster.

Cyclones and other disaster events affect the human capital development of children and thus hindering their income-earning potential as adults, suggesting that interventions in disaster-affected regions to help households recover their livelihoods are also important to reduce the long-term human-capital impacts. Our results suggest that such interventions should focus on rural infrastructural development to decrease rural-urban differences and improve market access, inclusive initiatives to reduce gendered variations in livelihood opportunities, and foster better schooling opportunities in rural areas. These policy suggestions for Bangladesh may be relevant for other developing countries with frequent exposure to disasters.

Especially in rural areas, development of facilities to meet basic health and schooling needs can lower such long-lasting adversities on children. Such an expansion of primary schooling and basic healthcare facilities occurred in Bangladesh immediately after independence, which led to rapid development of healthcare and schooling infrastructure during the post-1971 era. In particular, the government of Bangladesh nationalized primary schooling in 1974, which was eventually made free and compulsory for all. This intervention would have affected the schooling of all the treatment cohorts we analyzed, and therefore could have mitigated some of the long-run impacts of the cyclone in terms of schooling outcomes.

Improved parental schooling as well as targeted infrastructure investments, such as schools, hospitals, and shelters, may also have remedial influences on the adverse impacts of a disaster, such as a cyclone. Relatively educated parents are more aware that defensive measures adopted during and after a disaster can reduce any resulting losses (Haque *et al.* 2012). In addition, specific types of infrastructure, such as schools and hospitals, may counteract the potential long-term effects of a disaster (Banerjee *et al.* 2010; Cutler, Deaton, and Lleras-Muney 2006). Over the past 50 years, mortality and morbidity from disasters have fallen substantially in the coastal areas of Bangladesh, partly because of improvements in disaster management in the form of the construction of thousands of cyclone shelters (Cash *et al.* 2014; Haque *et al.* 2012).

Despite its unique contributions, our paper has some limitations which might open up avenues for future research. In particular, we have a small sample size due to focusing on a historical event that took place long ago. Future investigation either can consider a more recent event as a natural experiment, or can conduct a primary survey to collect a larger dataset which can be representative of disaster cohorts and regions. In addition, we made a restrictive assumption that people were born where they currently live due to unavailability of data. Although we adopted some measures to reduce the possibility of mismatch between birthplace and residence, future research can benefit from using a better dataset with information on birthplace. Finally, our estimates of selections into mortality and fertility have some limitations which can also be reduced by using a larger dataset.

Tables

Table 1. Timeline of deadly events in Bangladesh, 1970-74.

Year	Event	Severity	Regions	Cohorts
1970	The Great Bhola Cyclone	More than 0.30 million people died in southern Bangladesh	2. Barisal and Noakhali 1. Faridpur and Khulna 0. Jessore and Rajshahi	1. 1969-71 0. 1961-68 and 1972-80
1971	The Liberation War of Bangladesh	Up to 3 million people died	Entire Bangladesh	1. 1970-72 0. 1961-69 and 1973-80
1974	The Bangladesh Famine	Up to 1.5 million people died in northern Bangladesh	Rangpur, Mymensingh, Bogra and Pabna	1. 1973-75 0. 1961-72 and 1976-80

Notes. Timeline of the 1970-74 deadly events in Bangladesh is adapted from van Schendel (2009), EM-DAT (2020) and Sommer and Mosley (1972). Regions refer to *2* if severely affected regions, *1* if mildly affected neighboring regions, and *0* if unaffected regions. Cohorts stand for *1* if affected cohorts and *0* if unaffected cohorts.

Table 2. Variable description and summary statistics.

Variables	Description	Mean	S.D.	Min.	Max.
Outcome variables					
Healthy	1 if good health and 0 if otherwise	0.82	0.39	0	1
Health	Total life-years without illness, completed years	28.45	14.30	0.00	45.00
Ln(Health)	Natural log of life-years without illness	2.92	1.38	0	3.83
Educated	1 if educated and 0 if otherwise	0.29	0.45	0	1
Schooling	Years of schooling	2.39	3.70	0.00	16.00
Ln(Schooling)	Natural log of years of schooling	0.69	0.98	0	2.83
Solvent	1 if solvent and 0 if otherwise	0.12	0.33	0	1
Expenditure	Monthly household per-capita expenditure, taka	1,110.10	753.12	235.34	12,283.50
Ln(Expenditure)	Natural log of per-capita expenditure	6.88	0.49	5.47	9.42
Control variables					
Location	1 if rural and 0 if otherwise	0.88	0.32	0	1
Gender	1 if male-headed household and 0 if otherwise	0.95	0.21	0	1
Parental Schooling	1 if at least 1 parent is educated and 0 if otherwise	0.06	0.24	0	1
Age	Age of the household Head	34.97	5.49	20.00	45.00
ALF	Birthyear agricultural labor force	82.72	6.65	56.39	91.40
Landholding	Landholding by the household, decimals	67.60	134.79	0	2,490

Notes. Summary statistics consider birth cohorts 1964-80 and exclude Chittagong, CHT and Dhaka regions, so that the number of valid observations is 2,725. Of them, the cyclone sample includes a total of 1,059 valid observations, as reported in Table A.2. Landholding is expressed in decimals where 1 acre = 100 decimals.

Table 3. Parallel trends.

	Health outcomes		Schooling outcomes		Consumption outcomes	
Variables	Healthy	Ln(Health)	Educated	Ln(Schooling)	Solvent	Ln(Expenditure)
Cyclone Region 1	-0.009	-0.033	-0.000	0.042	-0.040	-0.073
	(0.045)	(0.161)	(0.038)	(0.103)	(0.037)	(0.054)
Cyclone Region 2	0.015	0.050	0.045	0.037	-0.017	0.030
	(0.032)	(0.110)	(0.050)	(0.114)	(0.040)	(0.078)
Constant	0.834***	2.982***	0.340***	0.829***	0.145***	6.948***
	(0.016)	(0.050)	(0.024)	(0.073)	(0.030)	(0.030)
No. of Obs.	758	757	758	755	758	758
R-squared	0.001	0.000	0.002	0.000	0.002	0.006

Notes. Standard errors clustered at the district level are shown in parentheses. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively. The table investigates the parallel trends assumption by employing the regression $y_i = \alpha_0 + \sum_{j=1}^{2} \vartheta_j R_j + \epsilon_i$ for the untreated or control cyclone cohorts. We restrict the regressions to the corresponding estimating samples for our results in Table 3. Outcome variables, as identified in headers, follow the definitions in Table 2 and Section 3.3. Cyclone regions and cohorts follow the definitions from Table 1.

Table 4. Main results.

Variables	Health outcomes		Schooling outcomes		Consumption outcomes	
	Healthy	Ln(Health)	Educated	Ln(Schooling)	Solvent	Ln(Expenditure)
Cyclone Cohort	0.141	0.489	0.098	0.151	0.134	0.083
	(0.112)	(0.406)	(0.087)	(0.166)	(0.088)	(0.085)
War Cohort	-0.040	-0.140	-0.083	-0.121	-0.115	0.192*
	(0.073)	(0.269)	(0.106)	(0.232)	(0.092)	(0.103)
Famine Cohort	0.131	0.467	-0.110	-0.315	-0.220***	0.099
	(0.078)	(0.283)	(0.099)	(0.209)	(0.073)	(0.134)
Cyclone Region 1	0.038	0.133	-0.032	-0.089	-0.065	0.046
	(0.146)	(0.528)	(0.242)	(0.516)	(0.146)	(0.175)
Cyclone Region 2	-0.189*	-0.676*	0.298**	0.761**	0.395***	0.632***
	(0.098)	(0.352)	(0.144)	(0.284)	(0.093)	(0.136)
Cyclone Cohort × Cyclone Region 1 (i.e., $\hat{\beta}_1$)	-0.056	-0.201	-0.030	0.081	0.011	-0.029
	(0.064)	(0.226)	(0.089)	(0.189)	(0.063)	(0.090)
Cyclone Cohort × Cyclone Region 2 (i.e., $\hat{\beta}_2$)	-0.149*	-0.536*	-0.218**	-0.490**	-0.125**	-0.265**
	(0.086)	(0.308)	(0.101)	(0.190)	(0.053)	(0.121)
War Cohort × Cyclone Region 1	0.078	0.298	0.284***	0.354	0.077	0.219**
	(0.071)	(0.249)	(0.082)	(0.213)	(0.083)	(0.090)
War Cohort × Cyclone Region 2	-0.006	0.012	0.105	0.229	0.253**	0.435***
	(0.119)	(0.424)	(0.142)	(0.302)	(0.092)	(0.148)
Famine Cohort × Cyclone Region 1	-0.015	-0.042	0.006	-0.033	0.020	0.040
	(0.063)	(0.223)	(0.095)	(0.191)	(0.057)	(0.091)
Famine Cohort × Cyclone Region 2	-0.189	-0.664	0.025	-0.032	0.050	0.235**
	(0.158)	(0.556)	(0.111)	(0.252)	(0.095)	(0.101)
No. of Obs.	985	984	985	982	985	985
R-squared	0.215	0.212	0.248	0.279	0.269	0.463
Control Variables	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Thana FE	YES	YES	YES	YES	YES	YES
HIES FE	YES	YES	YES	YES	YES	YES

Notes. Standard errors clustered at the district level are shown in parentheses. ***, ** and * represent statistical significance at 1, 5 and 10 percent levels, respectively. The table presents estimates from regressions of whether exposure to the 1970 cyclone induces long-term health and schooling adversities, according to the empirical specification (2). Outcome variables, as identified in headers, follow the definitions in Table 2 and Section 3.3. Shock regions and cohorts follow the definitions from Table 1. All regressions include the indicator variables for year of birth, subdivision/thana of birth, and survey year. Parameters of interest, $\hat{\beta}_j \forall j = 1,2$, are given by the coefficients of (Cyclone Cohort × Cyclone Region 1) and (Cyclone Cohort × Cyclone Region 2). Detailed results are appended in Table A.3.

Table 5. Variations in the impacts of cyclone.

Variables	Health outcomes		Schooling outcomes		Consumption outcomes	
	Healthy	Ln(Health)	Educated	Ln(Schooling)	Solvent	Ln(Expenditure)
Locational variations *[1 if rural]*						
Rural × Cyclone Cohort × Cyclone Region 1	0.323**	1.185**	-0.056	-0.062	-0.334	-0.393
	(0.134)	(0.462)	(0.298)	(0.702)	(0.265)	(0.434)
Rural × Cyclone Cohort × Cyclone Region 2	0.056	0.186	-0.608***	-1.173**	0.449*	-0.292
	(0.134)	(0.477)	(0.175)	(0.429)	(0.245)	(0.268)
No. of Obs.	985	984	985	982	985	985
R-squared	0.224	0.222	0.252	0.283	0.278	0.471
Parental schooling variations *[1 if educated]*						
Parental Schooling × Cyclone Cohort × Cyclone Region 1	0.262	0.993	-0.523	-1.367*	-0.174	0.051
	(0.281)	(1.037)	(0.441)	(0.728)	(0.301)	(0.493)
Parental Schooling × Cyclone Cohort × Cyclone Region 2	0.357	1.379	-0.292	-1.239	-0.331	-0.127
	(0.383)	(1.417)	(0.466)	(0.852)	(0.311)	(0.387)
No. of Obs.	985	984	985	982	985	985
R-squared	0.218	0.215	0.252	0.284	0.272	0.464

Notes. Standard errors clustered at the district level are shown in parentheses. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively. Regressions follow the empirical specification (4) that includes additional interactions. Outcome variables, as identified in headers, follow the definitions in Table 2 and Section 3.3. Shock regions and cohorts follow the definitions from Table 1. Variables follow their respective definitions in Tables 1 and 2. Detailed results are reported in Tables A.4 and A.5.

Table 6. Selective mortality.

Variables	25th percentiles	75th percentiles
Cyclone Cohort × Cyclone Region 1	-0.001	0.000
	(0.806)	(0.000)
Cyclone Cohort × Cyclone Region 2	-0.000	0.000
	(0.796)	(0.000)
No. of Obs.	984	984
Control Variables	YES	YES
Year FE	YES	YES
Thana FE	YES	YES
HIES FE	YES	YES

Notes. Standard errors are shown in parentheses. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively. Regressions are based on the empirical specification (2). Outcome variable is *Ln(Health)* defined as the log of illness-free total life-years. Variables follow their respective definitions in Tables 1 and 2. Detailed results are appended in Table A.6.

Table 7. Selection into fertility.

	Results excluding parental schooling						Parental schooling as outcome variable	Selection into fertility	
	Health outcomes		Schooling outcomes		Consumption outcomes			District level	Region level
Variables	Healthy	Ln(Health)	Educated	Ln(Schooling)	Solvent	Ln(Expenditure)			
Cyclone Cohort × Cyclone Region 1	-0.055	-0.196	-0.026	0.110	0.005	-0.038	0.065	-0.444	-1.226
	(0.065)	(0.229)	(0.087)	(0.189)	(0.064)	(0.091)	(0.045)	(1.800)	(12.897)
Cyclone Cohort × Cyclone Region 2	-0.149*	-0.536*	-0.218**	-0.488**	-0.125**	-0.265**	0.026	-1.316	-4.690
	(0.086)	(0.307)	(0.101)	(0.190)	(0.054)	(0.122)	(0.045)	(1.764)	(12.897)
No. of Obs.	985	984	985	982	985	985	985	418	102
R-squared	0.215	0.212	0.248	0.275	0.268	0.462	0.073		
Control Variables	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	NO	NO	NO
Thana FE	YES	YES	YES	YES	YES	YES	NO	NO	NO
HIES FE	YES	YES	YES	YES	YES	YES	NO	NO	NO
No. of regions									6
No. of districts								25	

Notes. Standard errors clustered at the district level are shown in parentheses. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively. Regressions excluding *parental schooling* as a control follow the empirical specification (2), where the outcome variables, as identified in headers, follow the definitions in Table 2. Regression for *parental schooling* as the outcome variable follows the empirical specification (2). Regressions for selection into fertility are estimated using the specification $f_i = \alpha_0 + \theta C + \sum_{j=1}^{2} \vartheta_j R_j + \sum_{j=1}^{2} \beta_j \times (R_j \times C) + \epsilon_i$, where the outcome variable f_i denotes *fertility*. Shock regions and cohorts follow the definitions from Table 1. Detailed results are appended in Table A.7.

Table 8. Placebo test.

Variables	Health outcomes		Schooling outcomes		Consumption outcomes	
	Healthy	Ln(Health)	Educated	Ln(Schooling)	Solvent	Ln(Expenditure)
Placebo Cyclone Cohort × Cyclone Region 1	-0.078	-0.256	-0.144	-0.221	-0.006	-0.220**
	(0.071)	(0.248)	(0.102)	(0.259)	(0.073)	(0.094)
Placebo Cyclone Cohort × Cyclone Region 2	0.125**	0.445**	0.401***	0.936***	0.327**	0.482***
	(0.058)	(0.208)	(0.128)	(0.232)	(0.120)	(0.145)
No. of Obs.	705	705	705	704	705	705
R-squared	0.298	0.274	0.322	0.342	0.342	0.468
Control Variables	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Thana FE	YES	YES	YES	YES	YES	YES
HIES FE	YES	YES	YES	YES	YES	YES

Notes. Standard errors clustered at the district level are shown in parentheses. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively. Placebo regressions are based on the empirical specification (1) excluding ALF due to data unavailability before 1964 and with selection into agriculture. Outcome variables, as identified in headers, follow the definitions in Table 2 and Section 3.3. Control variables follow their respective definitions in Table 2. Shock regions and cohorts follow the definitions from Table 1. Detailed results are appended in Table A.8.

Figures

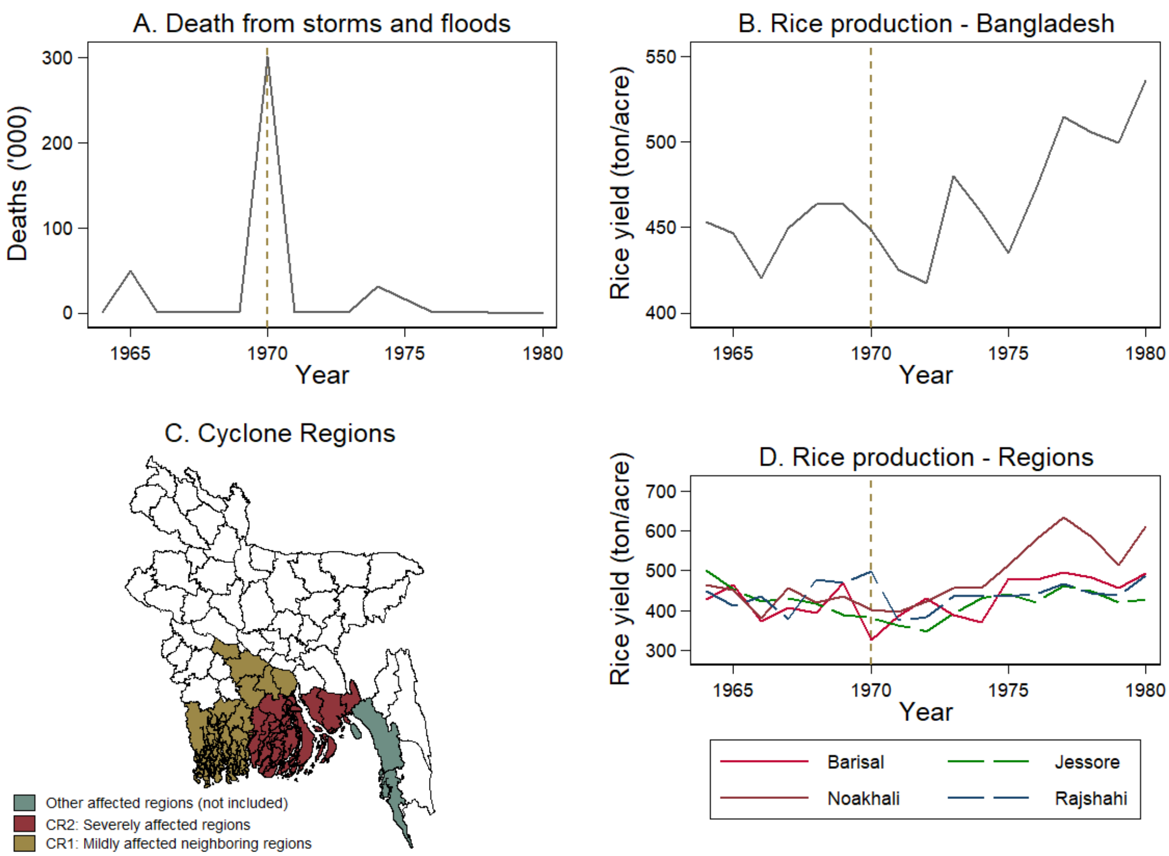

Fig. 1. The 1970 Bhola cyclone.

Data sources. Death numbers come from the EM-DAT database (EM-DAT 2020). Rice production data are obtained from various years of Statistical Yearbook of Bangladesh (BBS (various years)). Cyclone regions are identified based on EM-DAT database and Sommer and Mosley (1972).

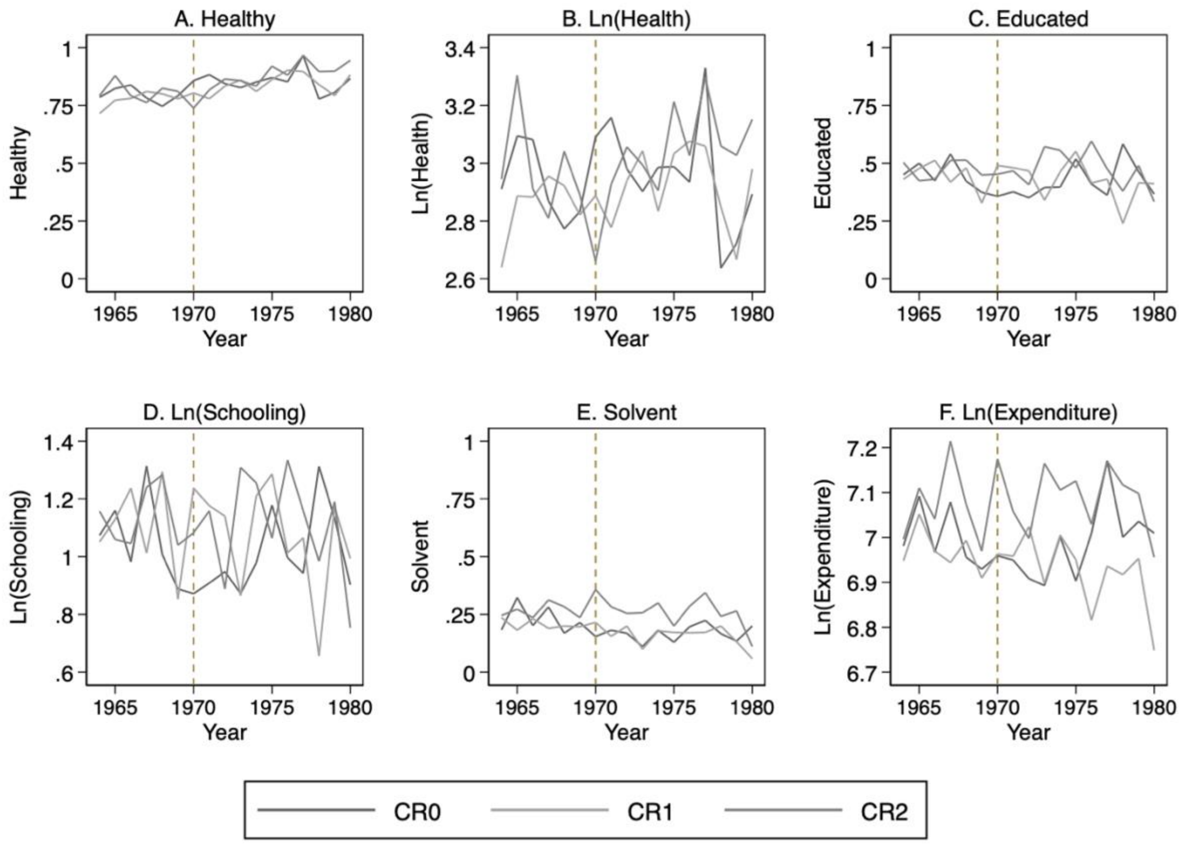

Fig. 2. Outcome variables over time by cyclone regions.

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Supplementary materials

(Online appendices)

Table A.1. Disasters in Bangladesh, 1900-2019.

Disaster subtype	Number of events	Total deaths	Total affected	Total damage
Drought				
Drought	7	1,900,018	25,002,000	--
Earthquake				
Ground movement	8	43	19,395	--
Tsunami	1	2	--	500,000
Epidemic				
Uncategorized	17	5,068	2,503,118	--
Bacterial disease	6	3,654	421,268	--
Parasitic disease	3	1,396	69,904	--
Viral disease	5	393,085	48,928	--
Extreme temperature				
Cold wave	19	2,182	313,200	--
Heat wave	2	62	--	--
Severe winter conditions	2	230	101,000	--
Flood				
Uncategorized	36	45,145	189,490,392	4,524,100
Coastal flood	2	51	473,335	--
Flash flood	11	261	7,634,577	729,000
Riverine flood	46	7,278	138,644,785	7,763,300
Landslide				
Landslide	5	105	74,299	--
Mudslide	1	160	80,187	--
Storm				
Uncategorized	49	5,706	2,356,857	850,000
Convective storm	40	2,168	1,470,091	40,401
Tropical cyclone	90	626,957	82,178,779	5,405,979

Notes. Table generated from EM-DAT database on April 28, 2020. Total deaths and affected figures denote historical total population died and affected from exposure to disasters during 1900-2019. Total damages are expressed in thousands of US$. "--" denotes data not available.

Table A.2. Summary statistics: Cyclone sample.

Variables	Description	Mean	S.D.	Min.	Max.
Outcome variables					
Healthy	1 if good health and 0 if otherwise	0.83	0.38	0	1
Health	Total life-years without illness, completed years	28.93	13.92	0.00	45.00
Ln(Health)	Natural log of life-years without illness	2.96	1.35	0	3.83
Educated	1 if educated and 0 if otherwise	0.32	0.47	0	1
Schooling	Years of schooling	2.69	3.80	0.00	16.00
Ln(Schooling)	Natural log of years of schooling	0.77	1.01	0	2.83
Solvent	1 if solvent and 0 if otherwise	0.12	0.33	0	1
Expenditure	Monthly household per-capita expenditure, taka	1,131.07	793.66	300.05	10,936.22
Ln(Expenditure)	Natural log of (one plus) per capita expenditure	6.89	0.49	5.71	9.30
Control variables					
Location	1 if rural and 0 if otherwise	0.85	0.36	0	1
Gender	1 if male-headed household and 0 if otherwise	0.96	0.19	0	1
Parental Schooling	1 if at least 1 parent is educated and 0 if otherwise	0.06	0.24	0	1
Age	Age of the household Head	34.97	5.33	20.00	45.00
ALF	Birth-year agricultural labor force	81.36	6.75	56.39	87.47
Landholding	Landholding by the household, decimals	69.75	141.78	0.00	1,320.00

Notes. Summary statistics consider cyclone regions and cohorts for agricultural households only, so that the number of valid observations is 1,059. Section 3.3 provides the detail description and construction of variables.

Table A.3. Complete main results.

	Health outcomes				Schooling outcomes				Consumption outcomes			
	Healthy		Ln(Health)		Educated		Ln(Schooling)		Solvent		Ln(Expenditure)	
Variables	Eq.(1)	Eq.(2)	Eq.(1)	Eq.(2)	Eq.(1)	Eq.(2)	Eq.(1)	Eq.(2)	Eq.(1)	Eq.(2)	Eq.(1)	Eq.(2)
Cyclone Cohort	0.117	0.141	0.408	0.489	0.060	0.098	0.089	0.151	0.032	0.134	0.309***	0.083
	(0.115)	(0.112)	(0.421)	(0.406)	(0.075)	(0.087)	(0.161)	(0.166)	(0.058)	(0.088)	(0.108)	(0.085)
War Cohort		-0.040		-0.140		-0.083		-0.121		-0.115		0.192*
		(0.073)		(0.269)		(0.106)		(0.232)		(0.092)		(0.103)
Famine Cohort		0.131		0.467		-0.110		-0.315		-0.220***		0.099
		(0.078)		(0.283)		(0.099)		(0.209)		(0.073)		(0.134)
Cyclone Region 1	0.118	0.038	0.408	0.133	-0.072	-0.032	-0.136	-0.089	-0.143	-0.065	-0.154	0.046
	(0.129)	(0.146)	(0.466)	(0.528)	(0.211)	(0.242)	(0.434)	(0.516)	(0.137)	(0.146)	(0.193)	(0.175)
Cyclone Region 2	-0.212**	-0.189*	-0.764**	-0.676*	0.274**	0.298**	0.708***	0.761**	0.350***	0.395***	0.571***	0.632***
	(0.090)	(0.098)	(0.327)	(0.352)	(0.127)	(0.144)	(0.251)	(0.284)	(0.090)	(0.093)	(0.145)	(0.136)
Cyclone Cohort × Cyclone Region 1	-0.012	-0.056	-0.037	-0.201	0.092	-0.030	0.243	0.081	0.033	0.011	0.043	-0.029
	(0.056)	(0.064)	(0.200)	(0.226)	(0.083)	(0.089)	(0.169)	(0.189)	(0.055)	(0.063)	(0.078)	(0.090)
Cyclone Cohort × Cyclone Region 2	-0.118*	-0.149*	-0.413*	-0.536*	-0.173**	-0.218**	-0.384***	-0.490**	-0.033	-0.125**	-0.128	-0.265**
	(0.060)	(0.086)	(0.219)	(0.308)	(0.076)	(0.101)	(0.131)	(0.190)	(0.042)	(0.053)	(0.095)	(0.121)
War Cohort × Cyclone Region 1		0.078		0.298		0.284***		0.354		0.077		0.219**
		(0.071)		(0.249)		(0.082)		(0.213)		(0.083)		(0.090)
War Cohort × Cyclone Region 2		-0.006		0.012		0.105		0.229		0.253**		0.435***
		(0.119)		(0.424)		(0.142)		(0.302)		(0.092)		(0.148)
Famine Cohort × Cyclone Region 1		-0.015		-0.042		0.006		-0.033		0.020		0.040
		(0.063)		(0.223)		(0.095)		(0.191)		(0.057)		(0.091)
Famine Cohort × Cyclone Region 2		-0.189		-0.664		0.025		-0.032		0.050		0.235**
		(0.158)		(0.556)		(0.111)		(0.252)		(0.095)		(0.101)
Location	-0.159	-0.142	-0.549	-0.495	-0.976***	-1.003***	-2.338***	-2.393***	-0.570***	-0.639***	-1.008***	-1.139***
	(0.121)	(0.132)	(0.440)	(0.480)	(0.194)	(0.213)	(0.376)	(0.409)	(0.152)	(0.166)	(0.213)	(0.219)
Gender	0.228	0.223	0.809	0.788	0.074	0.059	0.204	0.184	-0.256***	-0.264***	-0.248	-0.264
	(0.135)	(0.134)	(0.491)	(0.486)	(0.090)	(0.094)	(0.165)	(0.170)	(0.091)	(0.091)	(0.164)	(0.161)
Parental Schooling	0.012	0.014	0.050	0.058	0.040	0.042	0.302**	0.304**	-0.059	-0.057	-0.100**	-0.096**
	(0.057)	(0.059)	(0.207)	(0.211)	(0.065)	(0.065)	(0.132)	(0.132)	(0.044)	(0.043)	(0.045)	(0.042)
ALF	0.005	0.001	0.019	0.003	-0.005	-0.002	-0.013	-0.011	-0.021**	-0.017*	-0.022**	-0.011
	(0.008)	(0.010)	(0.028)	(0.035)	(0.013)	(0.015)	(0.026)	(0.031)	(0.009)	(0.010)	(0.011)	(0.010)
Age	0.022	0.021	0.133	0.130	-0.018	-0.019	0.079	0.080	-0.014	-0.010	0.009	0.015
	(0.026)	(0.028)	(0.096)	(0.099)	(0.036)	(0.037)	(0.078)	(0.080)	(0.031)	(0.030)	(0.028)	(0.028)
Squared Age	-0.000	-0.000	-0.002	-0.002	0.000	0.000	-0.001	-0.001	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.153	0.563	-0.860	0.543	3.044**	2.861*	5.032*	4.913	3.460***	3.141**	9.956***	9.068***
	(0.851)	(0.926)	(3.028)	(3.339)	(1.379)	(1.501)	(2.597)	(2.960)	(1.180)	(1.142)	(1.048)	(0.964)
No. of Obs.	985	985	984	984	985	985	982	982	985	985	985	985
R-squared	0.211	0.215	0.208	0.212	0.243	0.248	0.277	0.279	0.262	0.269	0.452	0.463
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Thana FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

HIES FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes. Standard errors clustered at the district level are shown in parentheses. ***, ** and * represent statistical significance at 1, 5 and 10 percent levels, respectively. The table presents estimates from regressions of whether exposure to the 1970 cyclone induces long-term health and schooling adversities, according to the empirical specifications (1) and (2). Outcome variables, as identified in headers, follow the definitions in Table 2 and Section 3.3. Shock regions and cohorts follow the definitions from Table 1. All regressions include the indicator variables for year of birth, subdivision/thana of birth, and survey year. Parameters of interest, $\hat{\beta}_j \forall j = 1,2$, are given by the coefficients of (Cyclone Cohort × Cyclone Region 1) and (Cyclone Cohort × Cyclone Region 2).

Table A.4. Locational variations.

Variables	Health outcomes: Healthy	Health outcomes: Ln(Health)	Schooling outcomes: Educated	Schooling outcomes: Ln(Schooling)	Consumption outcomes: Solvent	Consumption outcomes: Ln(Expenditure)
Cyclone Cohort	0.261*	0.914*	-0.035	-0.069	0.167	0.086
	(0.140)	(0.490)	(0.111)	(0.192)	(0.152)	(0.148)
Rural	-0.012	-0.024	-1.021***	-2.456***	-0.611***	-1.028***
	(0.133)	(0.474)	(0.217)	(0.413)	(0.199)	(0.266)
Cyclone Cohort × Rural	-0.164*	-0.581*	0.185**	0.308*	-0.040	0.015
	(0.089)	(0.291)	(0.087)	(0.153)	(0.103)	(0.139)
War Cohort	-0.037	-0.130	-0.074	-0.105	-0.126	0.188*
	(0.073)	(0.270)	(0.104)	(0.224)	(0.096)	(0.104)
Famine Cohort	0.135	0.480	-0.107	-0.313	-0.219***	0.119
	(0.081)	(0.292)	(0.098)	(0.211)	(0.074)	(0.134)
Cyclone Region 1	0.212	0.769	0.014	-0.102	-0.004	0.361
	(0.175)	(0.634)	(0.351)	(0.723)	(0.186)	(0.260)
Cyclone Region 2	0.119	0.444	0.169	0.436	0.514**	0.538**
	(0.123)	(0.444)	(0.280)	(0.584)	(0.212)	(0.225)
Cyclone Cohort × Cyclone Region 1	-0.327**	-1.196**	0.011	0.120	0.307	0.324
	(0.147)	(0.509)	(0.292)	(0.700)	(0.261)	(0.392)
Cyclone Cohort × Cyclone Region 2	-0.177	-0.624	0.332*	0.576	-0.541**	0.015
	(0.134)	(0.485)	(0.169)	(0.378)	(0.237)	(0.285)
Cyclone Region 1 × Rural	-0.193**	-0.704**	-0.042	0.013	-0.035	-0.280
	(0.071)	(0.252)	(0.215)	(0.387)	(0.113)	(0.224)
Cyclone Region 2 × Rural	-0.317***	-1.154***	0.145	0.351	-0.122	0.094
	(0.099)	(0.355)	(0.216)	(0.476)	(0.200)	(0.223)
Cyclone Cohort × Cyclone Region 1 × Rural	0.323**	1.185**	-0.056	-0.062	-0.334	-0.393
	(0.134)	(0.462)	(0.298)	(0.702)	(0.265)	(0.434)
Cyclone Cohort × Cyclone Region 2 × Rural	0.056	0.186	-0.608***	-1.173**	0.449*	-0.292
	(0.134)	(0.477)	(0.175)	(0.429)	(0.245)	(0.268)
War Cohort × Cyclone Region 1	0.084	0.318	0.274***	0.333	0.091	0.238**
	(0.073)	(0.256)	(0.080)	(0.210)	(0.075)	(0.086)
War Cohort × Cyclone Region 2	-0.008	0.004	0.090	0.199	0.265***	0.421***
	(0.114)	(0.406)	(0.129)	(0.276)	(0.093)	(0.149)
Famine Cohort × Cyclone Region 1	-0.013	-0.035	0.006	-0.034	0.021	0.042
	(0.064)	(0.225)	(0.098)	(0.194)	(0.057)	(0.091)
Famine Cohort × Cyclone Region 2	-0.192	-0.675	0.036	-0.010	0.044	0.249**
	(0.153)	(0.536)	(0.113)	(0.257)	(0.096)	(0.103)
Gender	0.225	0.797	0.055	0.175	-0.270***	-0.282*
	(0.132)	(0.479)	(0.100)	(0.182)	(0.089)	(0.163)
Parental Schooling	0.015	0.061	0.038	0.293**	-0.050	-0.100**
	(0.058)	(0.209)	(0.067)	(0.135)	(0.042)	(0.040)
ALF	0.000	0.003	-0.002	-0.011	-0.016	-0.009
	(0.010)	(0.036)	(0.015)	(0.032)	(0.010)	(0.010)
Age	0.019	0.124	-0.018	0.082	-0.011	0.013
	(0.029)	(0.103)	(0.037)	(0.081)	(0.030)	(0.027)
Squared Age	-0.000	-0.002	0.000	-0.001	0.000	0.000
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Constant	0.477	0.228	2.829*	4.919	3.082**	8.835***
	(0.969)	(3.490)	(1.547)	(3.071)	(1.167)	(1.000)
No. of Obs.	985	984	985	982	985	985
R-squared	0.224	0.222	0.252	0.283	0.278	0.471
Year FE	YES	YES	YES	YES	YES	YES
Thana FE	YES	YES	YES	YES	YES	YES
HIES FE	YES	YES	YES	YES	YES	YES

Notes. Standard errors clustered at the district level are shown in parentheses. ***, ** and * represent statistical significance at 1, 5 and 10 percent levels, respectively. Regressions extend the empirical specification (4) that includes additional interaction for location. Outcome variables, as identified in headers, follow the definitions in Table 2 and Section 3.3. Shock regions and cohorts follow the definitions from Table 1.

Table A.5. Parental schooling variations.

	Health outcomes		Schooling outcomes		Consumption outcomes	
Variables	Healthy	Ln(Health)	Educated	Ln(Schooling)	Solvent	Ln(Expenditure)
Cyclone Cohort	0.153	0.530	0.088	0.116	0.132	0.081
	(0.112)	(0.407)	(0.084)	(0.156)	(0.086)	(0.083)
Parental Schooling	-0.034	-0.068	-0.074	0.132	-0.165***	-0.066
	(0.105)	(0.367)	(0.172)	(0.361)	(0.058)	(0.051)
Cyclone Cohort × Parental Schooling	-0.133	-0.537	0.149	0.614	0.175	-0.099
	(0.269)	(0.996)	(0.362)	(0.593)	(0.235)	(0.352)
War Cohort	-0.039	-0.135	-0.091	-0.141	-0.124	0.194*
	(0.072)	(0.266)	(0.109)	(0.239)	(0.092)	(0.104)
Famine Cohort	0.134	0.479	-0.115	-0.332	-0.227***	0.095
	(0.079)	(0.285)	(0.100)	(0.212)	(0.072)	(0.135)
Cyclone Region 1	0.029	0.105	-0.055	-0.128	-0.087	0.048
	(0.149)	(0.537)	(0.243)	(0.511)	(0.143)	(0.177)
Cyclone Region 2	-0.198*	-0.706*	0.293**	0.753***	0.375***	0.629***
	(0.098)	(0.351)	(0.138)	(0.267)	(0.093)	(0.137)
Cyclone Cohort × Cyclone Region 1	-0.078	-0.277	0.013	0.188	0.015	-0.029
	(0.067)	(0.237)	(0.094)	(0.181)	(0.080)	(0.116)
Cyclone Cohort × Cyclone Region 2	-0.172*	-0.621*	-0.207*	-0.431**	-0.110**	-0.248*
	(0.098)	(0.349)	(0.105)	(0.195)	(0.053)	(0.125)
Cyclone Region 1 × Parental Schooling	0.032	0.040	0.268	0.368	0.093	0.036
	(0.131)	(0.466)	(0.204)	(0.414)	(0.078)	(0.136)
Cyclone Region 2 × Parental Schooling	0.044	0.088	0.206	0.428	0.242**	-0.035
	(0.175)	(0.641)	(0.226)	(0.454)	(0.104)	(0.104)
Cyclone Cohort × Cyclone Region 1 × Parental Schooling	0.262	0.993	-0.523	-1.367*	-0.174	0.051
	(0.281)	(1.037)	(0.441)	(0.728)	(0.301)	(0.493)
Cyclone Cohort × Cyclone Region 2 × Parental Schooling	0.357	1.379	-0.292	-1.239	-0.331	-0.127
	(0.383)	(1.417)	(0.466)	(0.852)	(0.311)	(0.387)
War Cohort × Cyclone Region 1	0.069	0.263	0.304***	0.397*	0.077	0.223**
	(0.069)	(0.242)	(0.086)	(0.221)	(0.083)	(0.093)
War Cohort × Cyclone Region 2	-0.005	0.015	0.111	0.240	0.256***	0.430***
	(0.127)	(0.455)	(0.138)	(0.283)	(0.091)	(0.146)
Famine Cohort × Cyclone Region 1	-0.018	-0.050	0.009	-0.036	0.010	0.047
	(0.064)	(0.223)	(0.091)	(0.184)	(0.059)	(0.096)
Famine Cohort × Cyclone Region 2	-0.197	-0.691	0.022	-0.031	0.043	0.244**
	(0.165)	(0.582)	(0.110)	(0.252)	(0.093)	(0.104)
Rural	-0.132	-0.455	-1.023***	-2.446***	-0.652***	-1.147***
	(0.137)	(0.496)	(0.205)	(0.391)	(0.166)	(0.221)
Gender	0.221	0.787	0.055	0.180	-0.268***	-0.267
	(0.137)	(0.495)	(0.092)	(0.170)	(0.090)	(0.165)
ALF	0.000	0.003	-0.003	-0.014	-0.019*	-0.011
	(0.010)	(0.035)	(0.015)	(0.031)	(0.009)	(0.010)
Age	0.019	0.124	-0.015	0.088	-0.009	0.019
	(0.028)	(0.099)	(0.037)	(0.078)	(0.029)	(0.026)
Squared Age	-0.000	-0.002	0.000	-0.001	0.000	0.000
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Constant	0.597	0.630	2.920*	5.126	3.334***	9.007***
	(0.942)	(3.393)	(1.536)	(3.016)	(1.110)	(0.957)
No. of Obs.	985	984	985	982	985	985
R-squared	0.218	0.215	0.252	0.284	0.272	0.464
Year FE	YES	YES	YES	YES	YES	YES
Thana FE	YES	YES	YES	YES	YES	YES
HIES FE	YES	YES	YES	YES	YES	YES

Notes. Standard errors clustered at the district level are shown in parentheses. ***, ** and * represent statistical significance at 1, 5 and 10 percent levels, respectively. Regressions extend the empirical specification (4) that includes additional interaction for parental schooling. Outcome variables, as identified in headers, follow the definitions in Table 2 and Section 3.3. Shock regions and cohorts follow the definitions from Table 1.

Table A.6. Selective mortality.

Variables	25 percentiles	75 percentiles
Cyclone Cohort	0.000	-0.001***
	(0.788)	(0.000)
War Cohort	0.000	-0.001**
	(0.777)	(0.000)
Famine Cohort	0.000	-0.001*
	(0.955)	(0.000)
Cyclone Region 1	0.000	-0.000
	(2.115)	(0.001)
Cyclone Region 2	-3.555**	-0.000
	(1.489)	(0.001)
Cyclone Cohort × Cyclone Region 1	-0.001	0.000
	(0.806)	(0.000)
Cyclone Cohort × Cyclone Region 2	-0.000	0.000
	(0.796)	(0.000)
War Cohort × Cyclone Region 1	0.001	0.000
	(0.908)	(0.000)
War Cohort × Cyclone Region 2	0.000	0.000
	(0.984)	(0.000)
Famine Cohort × Cyclone Region 1	-0.000	0.000
	(0.766)	(0.000)
Famine Cohort × Cyclone Region 2	-0.000	0.000
	(0.934)	(0.000)
Location	-0.000	0.000
	(0.924)	(0.000)
Gender	3.330***	0.000
	(0.678)	(0.000)
Parental Schooling	0.000	-0.000
	(0.504)	(0.000)
ALF	-0.000	-0.000
	(0.098)	(0.000)
Age	0.061	0.054***
	(0.269)	(0.000)
Squared Age	-0.000	-0.000***
	(0.004)	(0.000)
Constant	-1.300	2.148***
	(9.758)	(0.004)
No. of Obs.	984	984
Year FE	YES	YES
Thana FE	YES	YES
HIES FE	YES	YES

Notes. Standard errors are shown in parentheses. ***, ** and * represent statistical significance at 1, 5 and 10 percent levels, respectively. Regressions are based on the empirical specification (2) and are outlined in Section 6.1. Outcome variable is *Ln(Health)*. Shock regions and cohorts follow the definitions from Table 1.

Table A.7. Selection into fertility.

Variables	Results excluding parental schooling						Parental schooling as outcome variable	Selection into fertility	
	Health outcomes		Schooling outcomes		Consumption outcomes				
	Healthy	Ln(Health)	Educated	Ln(Schooling)	Solvent	Ln(Expenditure)		District level	Region level
Cyclone Cohort	0.141	0.488	0.097	0.146	0.135	0.085	0.016	3.339***	13.357
	(0.112)	(0.406)	(0.086)	(0.164)	(0.087)	(0.084)	(0.017)	(1.272)	(9.119)
War Cohort	-0.040	-0.140	-0.083	-0.121	-0.115	0.193*	0.020		
	(0.073)	(0.269)	(0.106)	(0.231)	(0.092)	(0.103)	(0.018)		
Famine Cohort	0.133	0.475	-0.104	-0.271	-0.228***	0.085	0.082***		
	(0.080)	(0.287)	(0.098)	(0.212)	(0.071)	(0.136)	(0.028)		
Cyclone Region 1	0.038	0.135	-0.031	-0.078	-0.067	0.043	0.063***	-2.640	-11.107
	(0.147)	(0.529)	(0.243)	(0.523)	(0.143)	(0.174)	(0.021)	(1.818)	(12.819)
Cyclone Region 2	-0.187*	-0.668*	0.304**	0.800***	0.388***	0.620***	0.059**	-3.413*	-11.143
	(0.099)	(0.356)	(0.145)	(0.285)	(0.091)	(0.139)	(0.029)	(1.768)	(12.819)
Cyclone Cohort × Cyclone Region 1	-0.055	-0.196	-0.026	0.110	0.005	-0.038	0.065	-0.444	-1.226
	(0.065)	(0.229)	(0.087)	(0.189)	(0.064)	(0.091)	(0.045)	(1.800)	(12.897)
Cyclone Cohort × Cyclone Region 2	-0.149*	-0.536*	-0.218**	-0.488**	-0.125**	-0.265**	0.026	-1.316	-4.690
	(0.086)	(0.307)	(0.101)	(0.190)	(0.054)	(0.122)	(0.045)	(1.764)	(12.897)
War Cohort × Cyclone Region 1	0.077	0.296	0.282***	0.343	0.079	0.223**	-0.006		
	(0.071)	(0.250)	(0.081)	(0.215)	(0.083)	(0.087)	(0.059)		
War Cohort × Cyclone Region 2	-0.007	0.009	0.103	0.216	0.255**	0.439***	-0.042		
	(0.118)	(0.421)	(0.142)	(0.302)	(0.093)	(0.151)	(0.061)		
Famine Cohort × Cyclone Region 1	-0.017	-0.048	0.002	-0.067	0.026	0.051	-0.076*		
	(0.062)	(0.219)	(0.095)	(0.189)	(0.056)	(0.093)	(0.042)		
Famine Cohort × Cyclone Region 2	-0.189	-0.664	0.025	-0.035	0.050	0.236**	-0.057		
	(0.158)	(0.558)	(0.110)	(0.251)	(0.092)	(0.100)	(0.045)		
Location	-0.141	-0.494	-1.002***	-2.384***	-0.640***	-1.141***	0.003		
	(0.132)	(0.477)	(0.212)	(0.405)	(0.166)	(0.220)	(0.033)		
Gender	0.223	0.790	0.061	0.196	-0.266***	-0.268	0.028		
	(0.134)	(0.486)	(0.093)	(0.178)	(0.091)	(0.160)	(0.047)		
ALF	0.001	0.003	-0.002	-0.009	-0.017*	-0.011	0.002		
	(0.010)	(0.035)	(0.015)	(0.032)	(0.009)	(0.010)	(0.001)		
Age	0.020	0.127	-0.021	0.062	-0.007	0.021	-0.081***		
	(0.027)	(0.097)	(0.037)	(0.081)	(0.030)	(0.027)	(0.022)		
Squared Age	-0.000	-0.002	0.000	-0.001	0.000	0.000	0.001***		
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)		
Constant	0.570	0.569	2.880*	5.046	3.116**	9.025***	1.109***	10.161***	40.643***
	(0.925)	(3.335)	(1.502)	(2.996)	(1.143)	(0.960)	(0.324)	(1.285)	(9.064)
No. of Obs.	985	984	985	982	985	985	985	418	102
R-squared	0.215	0.212	0.248	0.275	0.268	0.462	0.073		
Year FE	YES	YES	YES	YES	YES	YES	NO	NO	NO
Thana FE	YES	YES	YES	YES	YES	YES	NO	NO	NO
HIES FE	YES	YES	YES	YES	YES	YES	NO	NO	NO
No. of regions									6
No. of districts								25	

Notes. Standard errors clustered at the district level are shown in parentheses. ***, ** and * represent statistical significance at 1, 5 and 10 percent levels, respectively. Regressions excluding *parental schooling* as a control follow the empirical specification (2), where the outcome variables, as identified in headers, follow the definitions in Table 2 and Section 3.3. Regression for *parental schooling* as the outcome variable follows the empirical specification (2). Regressions for selection into fertility are estimated using the specification $f_i = \alpha_0 + \theta C + \sum_{j=1}^{2} \vartheta_j R_j + \sum_{j=1}^{2} \beta_j \times (R_j \times C) + \epsilon_i$, where the outcome variable f_i (i.e., *fertility*) is defined in Section 6.2. Shock regions and cohorts follow the definitions from Table 1.

Table A.8. Placebo test.

Variables	Health outcomes		Schooling outcomes		Consumption outcomes	
	Healthy	Ln(Health)	Educated	Ln(Schooling)	Solvent	Ln(Expenditure)
Placebo Cyclone Cohort	0.167	0.665	-0.282	-0.465	-0.308**	0.545***
	(0.160)	(0.594)	(0.175)	(0.336)	(0.127)	(0.145)
Cyclone Region 1	-0.061	-0.208	0.576***	1.255***	0.214***	0.527***
	(0.058)	(0.214)	(0.095)	(0.185)	(0.061)	(0.077)
Cyclone Region 2	-0.303***	-1.101***	0.000	-0.169**	-0.078***	-0.167***
	(0.020)	(0.073)	(0.042)	(0.074)	(0.025)	(0.040)
Placebo Cyclone Cohort × Cyclone Region 1	-0.078	-0.256	-0.144	-0.221	-0.006	-0.220**
	(0.071)	(0.248)	(0.102)	(0.259)	(0.073)	(0.094)
Placebo Cyclone Cohort × Cyclone Region 2	0.125**	0.445**	0.401***	0.936***	0.327**	0.482***
	(0.058)	(0.208)	(0.128)	(0.232)	(0.120)	(0.145)
Location	-0.081	-0.348	-1.022***	-2.301***	-1.089***	-1.297***
	(0.081)	(0.296)	(0.322)	(0.637)	(0.191)	(0.256)
Gender	0.036	0.136	-0.417***	-0.987***	-0.412***	-0.488***
	(0.130)	(0.490)	(0.149)	(0.304)	(0.139)	(0.123)
Parental Schooling	-0.019	-0.066	0.173**	0.482***	0.019	0.089
	(0.070)	(0.266)	(0.083)	(0.165)	(0.072)	(0.081)
Age	-0.003	0.061	0.028	0.103	-0.011	0.035
	(0.017)	(0.063)	(0.041)	(0.072)	(0.024)	(0.021)
Squared Age	0.000	-0.000	-0.001	-0.002**	0.000	-0.000
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)
Constant	1.016**	1.940	2.576***	4.905***	3.027***	8.141***
	(0.414)	(1.521)	(0.892)	(1.719)	(0.716)	(0.719)
No. of Obs.	705	705	705	704	705	705
R-squared	0.298	0.274	0.322	0.342	0.342	0.468
Year FE	YES	YES	YES	YES	YES	YES
Thana FE	YES	YES	YES	YES	YES	YES
HIES FE	YES	YES	YES	YES	YES	YES

Notes. Standard errors clustered at the district level are shown in parentheses. ***, ** and * represent statistical significance at 1, 5 and 10 percent levels, respectively. Placebo regressions are based on the empirical specification (1) excluding ALF due to data unavailability before 1964. Outcome variables, as identified in headers, follow the definitions in Table 2 and Section 3.3. Shock regions and cohorts follow the definitions from Table 1.