Title: The effect of rainfall extremes on physical intimate partner violence among recently married women in Bangladesh

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Overview

With climate change accelerating, human populations are increasingly facing and needing to adapt to climate variability and extreme weather events.[1,2] These conditions associated with climate change are already negatively impacting population health and wellbeing via a number of different pathways including exposure to increasing temperatures, extreme weather events, sea-level rise, diminished agricultural output, and climate variability.[3–5] Climate change has also contributed to a fivefold increase in the frequency of weather-related natural disasters, such as flooding and landslides, over the past 50 years.[6] In 2019, an estimated 95 million people were affected by natural disasters, 11,000 people were killed, and 103 billion dollars of damage was caused.[7] **As the world becomes less hospitable for human existence, the deleterious impacts of climate change-induced extreme events will intensify. Moreover, these effects will be particularly felt by socially and economically marginalized populations including women**.

In this study, we assess the impact of exposure to rainfall extremes on women's experience of intimate partner violence among a sample of recently married young women in rural Bangladesh. We hypothesize that women residing in communities with less than normal rainfall (i.e., drought conditions) or more than normal rainfall will experience a lower one-year risk of intimate partner violence compared to women residing in communities with normal rainfall. We further hypothesize that if the rainfall extremes cause a natural disaster, such as landslide or flood, women will experience a greater likelihood of violence compared to women not exposed to the natural disaster. We also investigate the impact of poverty and length of marriage as moderators of these relationships. Compared to women in newer marriages, we predict that women in who have been married for a longer period of time are less likely to see an impact from climate and weather stressors on intimate partner violence within their households. To test these hypotheses, we merge climatological data with a large multilevel population-based prospective cohort study of recently-married women in Rural Bangladesh.

Background

Countries in South Asia, such as Bangladesh, are increasingly facing extreme rainfall, often causing massive flooding.[7,8] **Many of these countries lack the resources and infrastructure to buffer their populations against the negative effects of such shocks.** Such exposures may lead to physical and emotional stress, increase food insecurity, and even death. Prior research studies have demonstrated that climate change-related variability often results in food, water, and other resource scarcities;[2,9–14] increased transmission of infectious diseases;[14–18] unreliable access to critical and life-saving healthcare;[19–22] and direct or indirect injuries and deaths.[14,23–

[25,3,21,20] These factors are particularly important in regions such as South Asia which tend to be largely agrarian and where irrigated farming is relatively uncommon; thus, farmers are highly-dependent on environmental conditions and rainfed agriculture.[26,27]

There are multiple pathways linking climate change/weather extremes to IPV. Food insecurity that might result from poor crop yields may also spur intimate partner violence as households try and cope with extreme stress.[11,28–31]Weather-related natural disasters may disrupt access to livelihoods and interfere with food production thereby increasing resource stress which in-turn may provoke household violence.[11,28–31] Meanwhile, deteriorated community cohesion and/or disconnection from former social safety nets and protections, both possible byproducts of climate extremes and natural disaster exposure, may also increase IPV within households.[32–34] **However, the influence that such extreme events have on household and partner dynamics, specifically intimate partner violence has rarely been addressed or explored in the scientific literature to date.**

Intimate partner violence remains an important global threat to public health. The risk of IPV is high worldwide; it is estimated that approximately 27% of ever-partnered women globally have experienced IPV in their lifetimes.[35] There is also considerable variability across contexts in the incidence, severity, and frequency of IPV. Country-specific median lifetime prevalence of IPV among ever-partnered women worldwide ranges from an estimated 10% to 53% for countries with available data.[35] In some parts of the world like South Asia, women experience some of the highest risk of IPV. In South Asia, an estimated 35% of women experience lifetime intimate partner violence.[35] In Bangladesh specifically, studies have reported a wide range of from 35% past year prevalence[36] to 57% lifetime prevalence among rural pregnant women[37] to 82.7% prevalence (in the past 10 months) among the same study population of young recently married women as in the current study.[38] Women bear a disproportionate burden as they are generally more likely to experience IPV than men.[2–6] Though women's vulnerability to IPV is multidimensional, it is driven in part by gender-based discrimination combined with bigotry targeted at other intersectional identities and sociodemographic characteristics (e.g., poverty and race).[39–42]

IPV can result in considerable acute and long-term sequelae among individuals that experience it, including physical injury, chronic pain, depression, and anxiety among other negative health outcomes.[43–47] Further, such violence can be severe enough to be fatal with femicides perpetrated by intimate partners accounting for a significant cause of mortality among women globally.[48]

Numerous psychological and individual-level predictors of IPV have been identified in the existing literature,[49–52] **yet few studies have attempted to examine how larger, macro-level processes (e.g., climate change and community violence) influence intrahousehold violence perpetration and victimization.**[53] Some research suggests that women may face increased risk of IPV in the aftermath of natural disasters, extreme weather, or other highly-disruptive events.[54,55] However, other studies posit that the liminal time between a household shock (e.g., an extreme weather event, a natural disaster, an armed conflict event) and full recovery may offer the possibility of

renegotiation of gender roles and power dynamics within partnerships, resulting in better conditions for women and possibly limiting (future) violence. [43–47]

A small but developing body of research has assessed the association between rainfall shocks and IPV. To date, results have been mixed, with some studies pointing to significant associations between drought conditions and increased IPV[58–60] while others find either no connection[58] or a marginal one.[59] Meanwhile, one study found that floods did not have a significant impact on IPV[60] and, in another qualitative study, some indication of an increase in gender-based violence after displacement due to flooding events.[61]

The purpose of this study is to test whether exposure to extreme rainfall is associated with incident IPV and severity of IPV over a 10-month period, in a population-based prospective cohort study in Rural Bangladesh. We secondarily test whether this association is modified by length of marriage.

Methods

Study population

In this study, we use data from the Influences of Women's Empowerment on Marriage and Violence in Bangladesh study. This was a population-based multistage, stratified prospective cohort study among married women conducted in rural Bangladesh in 2013 and 2014 – baseline interviews were administered from July to November in 2013 and 1-year follow up interviews were collected from June to September 2014. The aim of the original study was to examine contextual and community factors influencing intimate partner violence (IPV) risk.

The study followed international guidelines for IPV research (World Health Organization, 2001), including that a single respondent was drawn from each household to ensure the safety and confidentiality of participants, given the content of the interview (World Health Organization, 2001); moreover, participants and interviewers were matched by gender to build rapport and enhance disclosure of sensitive behaviors and practices (World Health Organization, 2001). The Institutional Review Boards at FHI 360 and the International Center for Diarrheal Disease Research, Bangladesh (ICDDR,B) approved the study.

For this secondary data analysis, we use IPV prevalence and severity data from the follow-up interview, which was collected in-person in June-September 2014. A total of 3,369 married women were interviewed. These respondents were nested within 77 rural villages. Further detail on the sampling and data collection process is described and published elsewhere.[62] Women were included in this analysis were selected for the original study if they were married in the prior 4–12 years.[62]

Measures

Independent variable: Rainfall extremes

We draw rainfall data from the publicly available dataset, Climate Hazards Center InfraRed Precipitation with Stations data (CHIRPS), which has a spatial resolution of 0.05°.[63] CHIRPS was established by the United States Geological Survey (UGS) and

the Climate Hazards Center at the University of California Santa Barbara and have precipitation data dating back from 1981 to the present.[64,65] These data are remote-sense based and high-resolution,[65] giving us flexibility to look at spatially and temporally granular exposures to rainfall extremes.

We operationalized rainfall at the upazila administrative unit. The upazila is a large geographic unit in Bangladesh, akin to a county subdivision political unit in some Western countries. The upazila is a mid-level geographic unit within the Bangladesh political geography: below the level of Division and District, but above the level of Union Councils, and Villages (in Rural Areas). The current population size of upazilas ranges from a minimum of 596,886 to a maximum of 1,634,750 people.

To measure the amount of rainfall in the geographic areas where survey respondents reside, we aggregate the rainfall data within the upazila boundary areas and created both averaged rainfall sums and 10-year rainfall deviation values (Z-scores). However, because there might be geographic spillover in the effect of rainfall extremes within these upazila boundaries, we also examine rainfall extremes at the pixel level within each upazila. This approach is essentially looking at whether a smaller area within the upazila experienced a rainfall extreme that might have been averaged away at the higher-level spatial aggregation. With these two rainfall measures, we spatially merge these data with the georeferenced survey data at the upazila level using rainfall measures which occur temporally before the assessment of our outcome of IPV.

Dependent variables: Prevalence and severity of physical intimate partner violence
IPV data were collected from seven survey questions that were adapted from the well-validated Revised Conflict Tactics Scale (CTS2).[66,67] These survey items, for example, included the following question asked to women about their husband in regards to his violent behavior:

- “has your husband done things that scared or intimidated you on purpose”
- “has your husband hit you with his fist or with something else that could hurt you”
- “has your husband kicked, dragged, or hit you repeatedly”
- “has your husband used a gun, knife, or other weapon against you”

We created a binary *prevalence of recent IPV* measure, which indicated no exposure to any of the violent behaviors queried or exposure to at least one of the violent behaviors queried, since baseline (i.e., in the last 10 months). Further, for each behavior, respondents were asked about how often the behaviors had occurred since the baseline data collection (which corresponds to the past 10 months).[62] We used this frequency information to establish a measure of *severity of IPV*, which ranged from 0 to 28. The use of this version of the outcome is a key strength because it is more plausible that exogenous stressors like climate events will exacerbate IPV that is already occurring, compared to inciting it de novo.

Effect Modifiers and Covariates. We adjust for a range of covariates, measured in the baseline survey (July to November 2013), including women’s age, time since marriage, household wealth, and education level. We also test whether length of marriage, or

socioeconomic status (education or household wealth) moderate our key association of interest (extreme rainfall and IPV).

Analysis

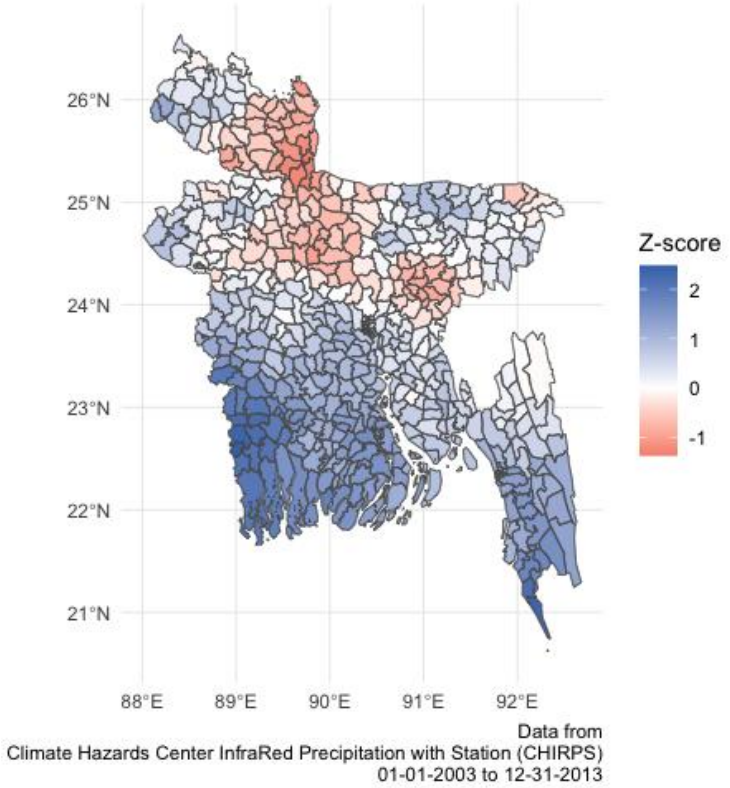
To assess the impact of rainfall extremes on respondents' exposure to IPV, we spatially and temporally link the survey data to external rainfall data (i.e., CHIRPS). We process the rainfall data as described above in the measures section.

We then run two separate regression models – one for each of our two rainfall exposure variables – that account for the population based multistage clustering design of the survey data. We use multilevel mixed-effects logistic regression models that account for the geographical clustering of women within specific community samples that is inherent in the sampling design. We then estimate the associations between our two rainfall extremes variables and two IPV outcomes: *prevalence of recent IPV* and *severity of IPV*. IPV variables capture if a respondent has experienced any type of IPV in the past year. We estimate separate models for each of the exposures and IPV measure pairing. Lastly, we test to see if socioeconomic status or length of marriage moderates the relationships between the exposures and IPV outcomes, by testing interactions between extreme rainfall and these moderators.

Preliminary Results

Figure 1 presents the variation in rainfall throughout Bangladesh in year 2013, from Climate Hazards Center InfraRed Precipitation with Stations (CHIRPS) data, which corresponds to the year and agricultural season before our outcome data collection in the cohort study. In this figure red indicates drier than normal conditions, and blue indicates wetter than normal conditions. You can see that there is considerable variation, and we have corresponding survey data from several upazilas across the country.

Figure 1. 10-year precipitation anomalies in 2013 aggregated at the upazila level in Bangladesh



We present preliminary logistic regression results of our primary hypothesis of interest in Table 1, focusing on binary IPV. We find that women who lived in areas with higher-than-average rainfall experienced a lower risk of any physical IPV over a 10-month period, in both bivariate and covariate adjusted models, compared to those that resided in areas that did not experience higher than normal rainfall. For example, a 1 standard deviation increase in rainfall was associated with a 0.84 decreased odds of incident IPV, or 16% less [crude odds ratio: 0.84; 95% confidence interval: 0.76-0.94].

Table 1. Crude and adjusted models of physical intimate partner exposure

		Crude			**Covariate adjusted**	
Predictors	*Odds Ratios*	*CI*	*p*	*Odds Ratios*	*CI*	*p*
Intercept	1.05	0.96 – 1.15	0.244	0.04	0.02 – 0.09	**<0.001**
2013 Rainfall Z-score	0.84	0.76 – 0.94	**0.002**	0.88	0.79 – 0.99	**0.029**
Respondent's age, years				1.12	1.08 – 1.16	**<0.001**
Years married				0.96	0.92 – 1.01	0.106
Repondent's education				1.22	1.09 – 1.37	**0.001**
Household wealth				1.30	1.16 – 1.45	**<0.001**
Partner's education				1.27	1.16 – 1.40	**<0.001**
Observations	2998			2998		
R^2 Tjur	0.003			0.076		

Table 2 presents preliminary multilevel linear regression model results examining how rainfall is associated with the severity/frequency of IPV. We find that women living in areas with more rainfall have worse severity/frequency of IPV in crude models. A one standard deviation change in rainfall is associated with a .05 increase in IPV severity (B=.05, 95%CI 0.00-0.09, p=.028). However, this rainfall-IPV severity association is accounted for by the covariate adjustment, as the coefficient declines to 0.02 (95%CI: -0.02-0.06, p=0.26).

Table 2. Crude and adjusted models of severity of physical intimate partner exposure

	Crude			Covariate adjusted		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
Intercept	0.66	0.63 – 0.70	**<0.001**	1.62	1.38 – 1.87	**<0.001**
2013 Rainfall Z-score	0.05	0.00 – 0.09	**0.028**	0.02	-0.02 – 0.06	0.260
Respondent's age, years				-0.02	-0.04 – -0.01	**<0.001**
Years married				-0.01	-0.02 – 0.01	0.314
Repondent's education				-0.10	-0.14 – -0.06	**<0.001**
Household wealth				-0.08	-0.12 – -0.04	**<0.001**
Partner's education				-0.06	-0.10 – -0.03	**<0.001**
Observations	2998			2998		
R^2 / R^2 adjusted	0.002 / 0.001			0.062 / 0.060		

We will complete the analyses, including to test effect modification hypotheses, by the 2026 conference date.

Preliminary Discussion

Based on preliminary analyses and results, we anticipate that higher than average rainfall will be associated with greater likelihood of experiencing IPV and the association will be particularly strong among impoverished women– those who likely don't have access to sufficient resources to buffer them from climatic and conflict shocks. Few studies have evaluated the influence of climate shocks on IPV, yet, we know that climate shocks may hypothetically incite or, alternatively, limit intrahousehold violence. Previous research has found linkages between external household shocks, coping mechanisms, and women's decision-making power within their households.[68–70] However, individuals, households, and communities may respond to shocks in a number of different ways.

This study adds to existing research by providing a better understanding of how macro-level, contextual processes might impact intrahousehold dynamics and the likelihood of violence within a partnership or household. In the face of climate shocks, we explore how individuals and households respond to shocks and whether such household stressors increase the risk of IPV. Because IPV poses a serious threat to women's health and well-being, elucidating the complex, multifactorial, and multilevel etiology of IPV is critical for devising effective interventions to reduce its incidence.

The findings of this study highlight the role of climate change in contributing to IPV risk and, consequently, the need to develop sustainable and multipronged policies and interventions that address both the immediate needs of people in crisis settings as well as the long-term impacts. With this information, we may be able to better anticipate spikes in IPV prevalence as well as to try and provide services to people during and after times of immense disruption such as that caused by climate shocks. Importantly, if IPV is indeed significantly linked to these household shocks, it will be essential to augment climate mitigation efforts with IPV prevention interventions.

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