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Article

Extreme Weather Events Due to Climate Change and Associations with Mental Disorders in Bangladesh, 2015–2020: A National Population-Based Survey

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Abstract

Background: Little is known about how disaster exposure interacts with household characteristics to influence mental health in Bangladesh. This study examined associations between household and disaster-related factors and the occurrence of mental disorders during and after climatic disasters in Bangladesh between 2015 and 2020. **Methods:** This cross-sectional study analyzed data from the 2021 Bangladesh Disaster-Related Statistics (BDRS), covering 125,952 households. The outcome was self-reported mental disorder during or after climatic disasters. Hierarchical Bayesian logistic regression models were used to examine associations, with adjusted odds ratios (ORs) and 95% credible intervals (CrIs) reported. **Findings:** Exposure to coastal erosion, landslides, or salinity (OR = 3.32; 95% CrI: 1.17–10.23) was associated with increased risk of mental disorder. Higher risk was also found in households headed by divorced/separated individuals (OR = 3.64; 95% CrI: 1.40–8.76), labourers (OR = 1.41; 95% CrI: 1.01–1.98), and unemployed persons (OR = 3.13; 95% CrI: 1.55–6.03). Households with a chronically ill member (OR = 3.48; 95% CrI: 2.36–5.10), malnourished child (OR = 5.17; 95% CrI: 3.14–8.35), or someone with disability (OR = 3.66; 95% CrI: 2.60–5.15) were at elevated risk. Agricultural/property loss (OR = 1.08; 95% CrI: 1.02–1.14) and housing damage (OR = 1.06; 95% CrI: 1.01–1.12) were linked to post-disaster mental disorders. **Interpretation:** Mental health support and social protection should be integrated into climate resilience planning, especially for socioeconomically disadvantaged households.

Keywords: Bayesian analysis; climate refugees; disaster resilience; household vulnerability; post-disaster health; psychosocial risk factors

Research in context

Evidence Before this Study

Adverse weather events, such as floods, droughts, cyclones, and salinity intrusion, disproportionately affect vulnerable populations by exacerbating food insecurity, displacement, livelihood loss, and psychosocial stressors. Previous studies have shown links between extreme

weather events and increases in post-traumatic stress disorder (PTSD), depression, anxiety, and substance use, particularly among poor and displaced populations. However, most existing studies have focused on individual-level outcomes and high-income settings, with limited empirical evidence from resource-limited settings on how household-level characteristics shape the risk of mental disorder during and after climatic disasters. To date, no studies in Bangladesh have systematically examined these relationships at the national scale, despite the country's high exposure to climate-related hazards and its fragile public health infrastructure.

Added Value of this Study

This study is the first nationally representative analysis of household-level mental disorder risk associated with exposure to climatic disasters between 2015 and 2020 in Bangladesh. Using data from 127,200 households collected in the 2021 Bangladesh Disaster-Related Statistics (BDRS), we applied hierarchical Bayesian logistic regression to identify key socio-economic, climatic, and health-related risk factors associated with mental disorders during and after disasters. This study found that households exposed to coastal hazards, led by divorced, unemployed, or day labourers, and those with chronic illness, malnourished children, or disabilities had significantly higher risks of mental disorders during and after disasters. In contrast, higher income, and disaster preparedness were protective. These findings highlight the structural and household-level vulnerabilities shaping climate-related mental health outcomes.

Implications of all the Available Evidence

These findings underscore the urgent need for mental health systems that integrate climate resilience strategies, including household-level preparedness, community-based psychosocial support, and long-term investment in health and social protection systems. Policies targeting mental health in disaster-prone communities in low- and middle-income countries must move beyond individual disaster trauma to address the broader structural determinants that shape household resilience in the face of climate change.

Background

Globally, between 1990 and 2023, an average of 364 adverse weather and climate events occurred annually, affecting about 400 million people each year.¹ A projected 17% reduction in global food production by 2050 is primarily attributed to diminished crop yields caused by climate change.² This reduction is anticipated to exacerbate homelessness, with approximately 140 million people to be displaced in low- and middle-income countries (LMICs).³ Bangladesh is a striking example, having experienced 185 climatic adversities between 2000 and 2019, resulting in the tragic loss of 11,450 lives and economic losses totalling \$3.72 billion in purchasing power parity.⁴

In 2021, Bangladesh ranked 7th among the ten most climate-affected countries, eight of the 10 nations are LMICs that ill-equipped to cope with the impacts of climate change.^{4,5} With an average of 1.2 million climate migrants annually, Bangladesh has witnessed a dramatic rise in internal displacement and urban overcrowding.^{6,7} The number of urban slums surged from 2,991 in 1997 to 13,938 in 2014, and by 2050, an estimated 13 million rural Bangladeshis will be internal climate migrants living in extreme poverty in urban settlements.⁸

Evidence is mounting that exposure to adverse climatic events as a major risk factor for increasing mental disorders including post-traumatic stress disorder (PTSD), depression, anxiety, phobias, sleep disorders, attachment disorders, and substance abuse.⁹⁻¹³ Aside from the near-death experience, climatic disasters can trigger environmental, neurobiological, socio-economic, and emotional stressors, ultimately increasing risks of adverse mental health outcomes.¹⁴ The psychological toll of disasters can manifest in various forms, including depression, anxiety, and post-traumatic stress disorder (PTSD), with certain populations being disproportionately affected based

on sociodemographic and economic factors. In the aftermath of an environmental disaster such as a cyclone, poor rural families often experience the worst outcomes given their fragile existence.^{7,15}

Despite the growing body of research on the mental health consequences of disasters, no studies have explored the complex interplay of household characteristics, disaster-related factors, and health vulnerabilities in shaping mental health outcomes at the national level in Bangladesh. Understanding these associations is critical for designing targeted interventions that enhance disaster resilience and mitigate adverse psychological impacts.¹⁶ Therefore, this study investigated the association between household and disaster-related characteristics and mental disorders during and after exposure to climatic disasters between 2015 and 2020 in Bangladesh.

Methods

Data Sources

The data analyzed in this study were obtained from the 2021 Bangladesh Disaster-related Statistics (BDRS), a nationally representative survey conducted by the Bangladesh Bureau of Statistics (BBS) on the behalf of the Government of Bangladesh. The survey employed a two-stage stratified random sampling approach, the survey selected households that were nationally representative, and respondents were drawn from these selected households. In the first stage, 4,240 primary sampling units (PSUs) were randomly selected using simple random sampling from a total of 29,199 PSUs, which were defined in the 2011 National Census and represent the smallest administrative areas, each covering approximately 120 households. These PSUs were selected from the most disaster-prone areas across the country's 64 districts.

In the second stage, 30 households were systematically selected from each of the disaster-prone PSUs (mauzas/mahallas) in the second stage. This methodology resulted in a total of 127,200 sample households selected from all 64 districts of Bangladesh affected by natural disasters over the last 6 years (2015-2020). The target population comprises all residents of the households. Further detailed information about this survey has been published elsewhere.^{17,18} This study included households (weighted) who reported disaster-related data.

Outcome

The primary focus of this study was household mental disorder during and following disasters. During the survey, household's head were asked, "Which diseases did household members primarily suffer from due to disasters from 2015 to 2020?". Respondents were given options to name the diseases they faced during the time of disaster and following the disaster. When respondents were unsure of disease names, trained data collectors (including healthcare personnel) assisted by clarifying symptoms and helping identify conditions based on descriptions. Responses were then reviewed to determine whether any household members experienced mental disorders during the disaster (yes/no) and after the disaster (yes/no).

This approach aligns with standard practice in household health surveys conducted in disaster-affected or low-resource settings, where clinical assessment is often not feasible. Proxy reporting by household heads, aided by trained data collectors, has been used in several humanitarian and disaster response surveys, and offers a valid, pragmatic method for identifying perceived mental health problems at the community level.¹⁹⁻²¹

Explanatory Variables

We included a comprehensive set of variables across four main categories: (a) socioeconomic characteristics; (b) household characteristics (c) disaster-related variables, (d) health problems in the household.

Sociodemographic and economic variables included the age and sex of the respondent, age and sex of the household head, household head's religion, education level, marital status, current

occupation, and place of residence. Household-characteristics included household’s total income, type of housing, receipt of financial or rehabilitation support, asset holdings, remittance status, and home ownership. Disaster-Related Variables included their awareness of disasters, the type of disaster experienced, and the extent of losses (e.g., land, agriculture, housing). It also covered preparedness measures for specific events such as floods, cyclones, and thunderstorms. Health-problems in the household included long term health conditions such as malnutrition, disabilities among members, and skin diseases.

Analysis

To analyse the association of climatic disasters on the outcome variable, we used hierarchical Bayesian logistic regression estimated via Markov Chain Monte Carlo (MCMC) using brms package. Multilevel approach was chosen over standard Bayesian logistic regression because it accounts for the nested structure of the data, such as households clustered within sampling units. The extent and intensity of disaster impact may be similar among households within a cluster but can vary significantly between clusters. Ignoring this clustering can result in underestimated standard errors and potentially misleading conclusions. By incorporating random effects, multilevel logistic regression produces more accurate estimates and valid inferences, effectively capturing both household-level and contextual (cluster-level) influences on mental disorders.²²

We incorporated weakly informative priors to stabilize the estimates and reduce overfitting, even when event counts are low, an advantage of Bayesian models. We used a Normal (0, 2) prior for all fixed-effect coefficients (class = 'b') in the logistic regression model. This prior assumes that most effects are modest but allows for some variability. We expected no significant prior effects but allowed for Odds Ratios (OR) between ~0.1 and ~10, avoiding implausibly large effects such as OR > 10. We used weakly informative default priors from the brms package for intercepts and group-level standard deviations, as no explicit priors were specified. Bayesian models are well suited for rare outcomes, avoiding issues like complete separation and providing stable estimates via weakly informative priors.²³ Furthermore, Bayesian inference provides full posterior distributions, allowing for more accurate uncertainty quantification and direct probabilistic interpretation of model parameters. It also handles model complexity such as random slopes or nonstandard likelihoods, more flexibly, without sacrificing convergence or interpretability.²⁴

For example, let Y_{ij} denote the presence of mental illness in the i^{th} household within the j^{th} cluster, where $Y_{ij}=1$ indicates the presence of mental illness, and $Y_{ij}=0$ indicates the absence, and the outcome variables was assumed to follows a Bernoulli distribution with probability P_{ij} ,

$$Y_{ij} \sim \text{Binomial}(P_{ij})$$

Let $X_{1ij}, X_{2ij}, \dots, X_{kij}$ represent household-level explanatory variables such as sociodemographic and disaster-related characteristics, measured for each household. If $\beta_1, \dots, \beta_k$ represent coefficients for household level variables. Our empirical model to estimate the effect of predictors on mental illness is specified as follows:

$$\begin{aligned} \text{Logit}(P_{ij}) &= \beta_0 + \beta_1 X_{1ij} + \beta_2 X_{2ij} + \dots + \beta_k X_{kij} + u_j \\ U_j &\sim N(0, \sigma_u^2), & \beta_{0j} &\sim N(0, \tau^2), & \sigma_u &\sim \end{aligned}$$

Half-Cauchy (0,2)

We assumed that the group-specific deviations u_j are drawn from a normal distribution with mean 0 and variance of the group-level effects σ_u . Each fixed effect $\beta_1 \dots \beta_k$ was assigned a normal prior with mean 0 and variance τ^2 , set as weakly informative ($\tau=2$). The standard deviation of the random intercepts at the group level, σ_u , was given a half-Cauchy (0, 2) prior.²⁵

Role of the Funding Source

Funders had no role in study design, data collection, data analysis, interpretation or writing of the report.

Results

A total of 125,952 households were included in this study. The mean age of the head of household was 46.84 (± 13.7) years, and the average monthly income was \$168 USD. Average disaster-related losses included approximately \$965 USD for land, \$593 USD for agricultural damage, and \$142 USD for household property, with substantial variability across households (see Table 1).

Risk Factors Associated with Mental Disorder During Disasters

During the disaster, households headed by divorced or separated individuals (OR = 3.28; 95% CrI: 1.50–6.75), day laborers (OR = 1.28; 95% CrI: 1.02–1.64), unemployed individuals or students (OR = 1.94; 95% CrI: 1.15–3.19), and those inactive for work (OR = 1.51; 95% CrI: 1.06–2.15) were associated with an increased risk compared to their respective reference groups. Households living in semi-pucca housing were associated with an increased risk of mental disorder compared to those in pucca houses (OR = 1.48; 95% CrI: 1.08–2.04), as were households with a member experiencing chronic illness (OR = 2.89; 95% CrI: 2.16–3.84), reporting malnutrition (OR = 3.49; 95% CrI: 2.46–4.98), or having a member living with a disability (OR = 2.37; 95% CrI: 1.80–3.10) (see Table 2).

Risk Factors Associated with Post-Disaster Mental Disorder

Households headed by divorced or separated individuals were associated with an increased risk of post-disaster mental disorder compared to those headed by unmarried or widowed individuals (OR = 3.12; 95% CrI: 1.74–5.49). Those headed by unemployed individuals or students (OR = 2.35; 95% CrI: 1.51–3.57) and labourers (OR = 1.28; 95% CrI: 1.02–1.64) were associated with an increased risk of mental disorder compared to agricultural workers. In contrast, households headed by business owners (OR = 0.76; 95% CrI: 0.57–0.99) and housewives (OR = 0.64; 95% CrI: 0.42–0.98) were associated with a decreased risk compared to those in agriculture (see Table 2).

Households with higher income were associated with decreased risk of post-disaster mental disorder compared to those with lower income (OR = 0.69; 95% CrI: 0.48–0.93), while those living in semi-pucca housing were associated with increased risk compared to those in pucca houses (OR = 1.51; 95% CrI: 1.13–2.03). Households that had taken measures for thunderstorms were associated with decreased risk of post-disaster mental disorder compared to those that had not (OR = 0.60; 95% CrI: 0.40–0.86).

Households that experienced higher levels of agricultural loss (OR = 1.08; 95% CrI: 1.02–1.14) and property damage (OR = 1.06; 95% CrI: 1.01–1.12) were associated with increased risk compared to those with little or no loss. Households with a member experiencing chronic illness (OR = 2.62; 95% CrI: 2.01–3.39), reporting malnutrition (OR = 2.06; 95% CrI: 1.48–2.81), or living with a disability (OR = 2.67; 95% CrI: 2.11–3.38) were all associated with increased risk of post-disaster mental disorder.

Risk Factors Associated with Mental Disorder During and After Disasters

Households headed by divorced or separated individuals were associated with increased risk of mental disorder during and after disasters compared to those headed by unmarried or widowed individuals (OR = 3.64; 95% CrI: 1.40–8.76). Households headed by day laborers were associated with increased risk compared to those headed by agricultural workers (OR = 1.41; 95% CrI: 1.01–1.98), as were households headed by unemployed individuals (OR = 3.13; 95% CrI: 1.55–6.03) (see Table 2).

Households exposed to coastal erosion, landslides, or salinity were associated with increased risk of mental disorder during and after disasters compared to those exposed to drought (OR = 3.32; 95% CrI: 1.17–10.23). Households with a member experiencing chronic illness were associated with increased risk compared to those without (OR = 3.48; 95% CrI: 2.36–5.10), as were households reporting malnutrition (OR = 5.17; 95% CrI: 3.14–8.35) and those with a member living with a disability (OR = 3.66; 95% CrI: 2.60–5.15).

Discussion

This study showed that households exposed to salinity intrusion, coastal erosion, and landslides were particularly vulnerable to mental disorders during and after these events between 2015 to 2020. Socio-economic risks of mental disorder during and after these adverse events including being headed the household by a divorced or separated individual, laborer, or unemployed person. Housing type and disaster-related property or agricultural losses also contributed significantly to mental disorder outcomes. Furthermore, households with a chronically ill member, child experiencing malnutrition, or person living with a disability were more likely to report mental disorder.

The relevance of disaster type was evident, with households exposed to slower-onset and prolonged stressors like salinity, river erosion, and landslides reporting higher mental health risks. These disasters are distinct from rapid-onset events like cyclones or floods because they erode livelihoods, damage agricultural productivity, and create chronic displacement, often without visible destruction. Such events are psychologically destabilizing over both short and long terms.²⁶ They disrupt basic subsistence and expose families to food insecurity, unemployment, and forced migration. Previous studies from Japan (the 2011 Great East Japan earthquake and tsunami)¹³ and Sweden (the 2004 Indian Ocean earthquake and subsequent tsunami)²⁷ have demonstrated that exposure to climate-related disasters, such as tsunamis and earthquakes, significantly increases the risk of post-traumatic symptoms, especially when compounded by pre-existing vulnerabilities or prolonged displacement. In Bangladesh, similar processes may unfold gradually, but the long-term mental health burden is likely to be just as significant—particularly as these disasters accumulate over time and compromise the resilience of communities.

Social and economic marginalization plays a crucial role in shaping post-disaster mental health. Our findings showed elevated risk among laborers, the unemployed, and households with unstable marital structures, groups that tend to have fewer economic buffers and weaker social safety nets. These vulnerabilities are likely amplified in contexts of extreme poverty, low educational attainment, and informal employment.⁸ In the aftermath of disasters, especially among internal migrants displaced to slums, survival often takes precedence over health. Studies from South Asia have shown that displaced families experience loss of routine, child neglect, and economic desperation, sometimes resorting to exploitative work or unsafe living arrangements.^{8,28} In these conditions, children are often left unsupervised, increasing the risk of adverse childhood experiences (ACEs) such as malnutrition, neglect, and abuse—all of which are known to have lasting impacts on mental health and developmental outcomes.²⁹⁻³¹

Individual household health vulnerabilities significantly contributed to disaster-related mental illness. Households with chronically ill members, children with malnutrition, or individuals living with disabilities were disproportionately affected. These conditions not only increase caregiving burdens but also amplify emotional stress during crisis events, especially in low-resource environments where access to healthcare is limited. Existing evidence suggests that familial dysfunction and prolonged exposure to climatic events can disrupt brain architecture and lead to long-term immune and inflammatory changes (e.g., elevated interleukin-6), which are associated with a range of psychosocial and physical disorders in adulthood, including cardiovascular disease, cancer, and depression.^{32,33}

These findings have significant implications for climate change and global health policy. As climate-related disasters become more frequent and diverse, especially in LMICs like Bangladesh, the cumulative effects on mental health will be profound. An estimated 13 million Bangladeshis may be climate migrants by 2050,⁸ many living in dense urban slums with minimal access to health or psychosocial support. This situation highlights the urgency of integrating mental health services into climate resilience and disaster preparedness frameworks.³⁴ Building resilient communities requires not only early warning systems and structural protection, but also investment in social protection, equitable housing, inclusive education, and primary care systems that can respond to psychological needs.^{35,36} For global health, these findings reinforce the necessity of shifting toward trauma-

informed, community-based, and preventive mental health strategies—particularly in climate-vulnerable settings.³⁷

Strengths and Limitations of the Study

One major limitation of this study is the low reported prevalence of household mental disorders (<3%) during and after disasters, which likely reflects under-recognition rather than a true absence of mental health impacts. In low-resource settings such as rural Bangladesh, household heads may only report severe or overt mental health conditions, while more common but less visible symptoms—such as anxiety, depression, or psychological distress—are often overlooked or unacknowledged by respondents.³⁸ Despite this, a key strength of the study is the use of hierarchical Bayesian logistic regression, a method well-suited for modelling rare outcome events. This approach enabled us to produce stable and robust estimates, even with low event rates, while appropriately accounting for household- and cluster-level variation. The use of a large, nationally representative dataset further enhances the generalizability of our findings on structural and household-level determinants of climate-related mental health vulnerability.

This study has several additional limitations. First, the use of cross-sectional data limits the ability to infer causality, and the findings should be interpreted as correlational. Second, reliance on self-reported information introduces the possibility of recall bias. Third, while the intensity and accessibility of health services likely influence disaster-related mental health outcomes, this factor could not be assessed due to the lack of relevant data in the survey. Similarly, key socioeconomic indicators such as household wealth quintiles were unavailable. Nonetheless, the study's methodological strengths and the scope of its analysis offer valuable evidence to inform targeted, equity-focused disaster preparedness and mental health interventions in climate-vulnerable settings.

Conclusions

Coastal erosion, landslides, and salinity directly disrupt livelihoods, displace communities, and damage essential infrastructure, significantly increasing household stress and vulnerability. These disasters exacerbate economic instability, leading to both immediate psychological distress and long-term mental health challenges. As a result, affected communities face heightened risks of mental disorders, compounded by ongoing recovery struggles and loss of social support systems. To mitigate the mental health consequences of disasters, targeted interventions should focus on strengthening disaster preparedness, expanding access to mental health services, and implementing social protection measures for at-risk populations. Community-based mental health programs, integration of mental health into disaster response frameworks, and financial support for affected households can help reduce the psychological burden of disasters. Future research should explore long-term mental health trajectories following disasters and assess the effectiveness of intervention strategies in improving psychological resilience.

Authors' Contribution: ST conceptualised the study idea, obtained and analysed the data, interpreted the results. ST drafted the original manuscript. GD, SG, MNK, MBA, SB, and KYA critically revised the manuscript for intellectual content. ST, and GD accessed the data and conducted the analysis. ST, GD and KYA contributed to interpretation and critically revised the manuscript. ST, GD, MNK, and MBA had full access to the raw data and, GD and MNK verified the data. All authors read and approved the final submission of the study for publication.

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Ethics approval: The survey was reviewed and approved by the Ethical Review Committee of the Bangladesh Bureau of Statistics (BBS). Written informed consent was obtained from all participants in this survey before their inclusion. We explored de-identified data from BBS by submitting a research proposal for this study. Additional ethical approvals were not required for this study.

Patient and public involvement: Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication: Not applicable.

Data availability statement: All the necessary information for the present study has been included by the authors in the publication. In order to access the entire dataset, researchers need to contact the Bangladesh Bureau of Statistics (<https://bbs.gov.bd>) and submit a formal study application.

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Competing Interests: The authors declare no conflict of interests.

List of Abbreviations

- ACEs: Adverse Childhood Experiences
- BBS: Bangladesh Bureau of Statistics
- BDRS: Bangladesh Disaster-related Statistics
- CrI: Credible Interval
- LMICs: Low- and Middle-Income Countries
- MCMC: Markov Chain Monte Carlo
- OR: Odds Ratio
- PTSD: Post-Traumatic Stress Disorder
- PSU: Primary Sampling Unit
- USD: United States Dollar

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