After the Rain - How Flood Exposure Impacts Acute Childhood Undernutrition in West Africa

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Abstract: *West Africa is among the most climate-vulnerable regions of the world, where floods have become increasingly frequent and severe. While prior research has emphasized the impact of drought, little is known about how floods affect child nutrition. This paper examines whether recent flood exposure, defined as a flood occurring within 12 months prior to the interview, influences acute child undernutrition in 12 West African countries. Drawing on 44 Demographic and Health Surveys (2000–2023) linked with geocoded disaster data (GDIS, EM-DAT), I analyze 270,850 child records. Preliminary results indicate that children exposed to recent floods have significantly lower weight-for-height z-scores (–0.11 SD, p<0.001) and have 20% higher odds of being wasted. The effects of flooding on childhood wasting are strongest among younger children and are partly buffered by maternal education. Current findings highlight the detrimental immediate impacts of flooding on child nutrition.*

Introduction

West Africa[1] is one of the world's most climate-vulnerable regions, where the frequency and intensity of extreme weather events are rising rapidly. Although the region contributes minimally to global greenhouse gas emissions, it endures a disproportionate share of the adverse effects of climate change. Temperatures are increasing at a faster rate than the global average, and rainfall patterns have become increasingly erratic (USAID, . Once primarily associated with prolonged droughts, particularly in the Sahel, West Africa now faces an important increase in the frequency and severity of flooding events (Barry et al., 2018; Ekolu et al., 2022; Kennedy et al., 2017; Nicholson et al., 2018;

Although climate-related risks in West Africa have become increasingly well-documented, the specific relationship between flooding and child nutrition remains underexplored. Much of the existing literature on climate shocks and malnutrition has focused on South Asia, particularly Bangladesh (Baten et al., (Rodríguez-Llanes et al., 2011; Rahman et al., , India , Nepal (Gaire et al., , and Pakistan (Hossain et al., . Within the West African context, most studies have primarily examined the economic consequences of climate variability, including agricultural productivity, household consumption, and poverty levels(: When cross-country studies in sub-Saharan Africa do exist, they often rely on broader indicators of climate variability, such as deviations in rainfall or temperature (Davenport et al., 2017; which are unable to capture the abrupt effects of flooding events explicitly. Moreover, most studies continue to emphasize

[1] This region consists of Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo.

drought as the dominant climate risk in the region (Cooper et al., 2019; Hoddinott & Kinsey, 2001), leaving the impacts of floods on population health relatively understudied despite their growing prevalence and severity. This has resulted in a limited and fragmented body of research focused on West Africa.

The goal of this paper is to address current gaps in the literature by examining the association between recent flood exposure and short-term nutritional stress in children. Flooding is a climate-related shock that has substantial immediate risks to children's health and nutrition. It increases children's risk of exposure to infectious diseases, undermines household economies, interferes with existing food systems, and restricts households' access to essential health services. These climate shocks have vital consequences in settings such as West Africa, where existing climate and food security vulnerabilities are exacerbated by fragile infrastructure, high dependence on agriculture and limited capacity to mitigate the impacts of environmental hazards.

Additionally, while floods are indiscriminate and can equally impact and create equal exposure risks for child health and nutrition, their impacts are not uniform. Instead, children's vulnerabilities are shaped by biological, household, and structural factors that lead to differences in harm conditional on exposure to risk and the capacity to cope. As such, to better understand the varying and complex effects of flooding on children's nutritional health, this paper also explores how the impact of recent flood exposure may vary across key sociodemographic groups, specifically by child age and sex, maternal education and employment, household wealth and place of residence (urban/rural).

Data and Research Methods:

Data presented in this study come from Demographic and Health Surveys (DHS) conducted across 12 West African countries. The sample is drawn from 44 DHS surveys conducted between 2000 and 2023. The selected countries (and their number of surveys used) are: Benin (4), Burkina Faso (3), Côte d'Ivoire (2), Gambia (2), Ghana (4), Guinea (3), Liberia (3), Mali (4), Niger (2), Nigeria (4), Senegal (10), and Sierra Leone (3). The final analytical sample consists of 270,850 child-level anthropometric records (weight-for-height and wasting) spanning the 23-year study period. Sampling weights were applied in all analyses.

Flood exposure is measured using two complementary sources: the Geocoded Disasters (GDIS) Dataset and the Emergency Events Database (EM-DAT). The GDIS dataset serves as the primary data source for constructing the flood exposure variable, as it provides geospatial information on disaster-affected areas at the first subnational administrative level (e.g., province or region). Developed by geocoding disaster records reported in EM-DAT, GDIS enhances spatial analyses by enabling the alignment of disaster events with children's provinces of residence in the DHS between 2000 and 2018. To supplement the spatial coverage of GDIS and extend the disaster timeline through 2023, I incorporate data from the original EM-DAT database. The EM-DAT database is used in two key ways. First, I extract the start and end dates of each flood event,

information not available in GDIS, to more precisely determine the timing of exposure for children living in an affected region. This temporal information enables the precise identification of whether a flood occurred within the 12-month window preceding the survey, which is crucial for classifying children who have been recently exposed to flooding. Second, because the GDIS only includes disaster occurrences up to 2018, I utilize the EM-DAT database to identify and incorporate flood events that occurred between 2019 and 2023. For this period, although EM-DAT does not provide standardized geocodes, I manually match disaster records to subnational regions using reported location names. These newer records are harmonized with GDIS events to ensure consistent geographic classification across the whole observation period. With these two datasets, I define flood exposure as exposure to a flood within the 12 months prior to the DHS interview, including the month of the interview.

Preliminary Findings:

Table 1 presents weighted descriptive statistics for the child-level analyses. Approximately 11% of children in the analytical sample were wasted. The average weight-for-height-z-score in the sample was -0.41. Within this sample, one-third (33%) of children resided in areas that experienced a flooding event in the 12 months to the DHS interview.

(insert Table 1)

How do floods impact children's nutritional health in West Africa?

Table 2, Model 1 presents the estimates from my OLS regression, which reveals a negative and statistically significant association between flood exposure and weight-for-height (WHZ). Specifically, I find that children exposed to a flooding event within the 12 months preceding the DHS interview had WHZ scores that were 0.11 standard deviations lower than those of children who had not experienced a recent flooding event, suggesting that flood exposure contributes to acute nutritional stress. The logistic regression model, which assessed whether flood exposure is associated with an increased likelihood of wasting, similarly indicates a statistically significant relationship between flood exposure and childhood malnutrition. In this second model, exposure to flooding in the previous year? increases the odds of wasting by 20%, further highlighting the short-term nutritional consequences of environmental shocks such as flooding.

(insert Table 2)

The heterogeneous effects of flood exposure:

Figure 1 presents the predictive margins for the interaction between flood exposure and child age (in months), examining whether the effects of flooding differ across early childhood. Here, the results indicate that child age is a significant moderator; as children grow older, their predicted probability of wasting steadily declines, though children exposed to flooding consistently face

higher risks than those unexposed. For example, at 6 months old, the predicted probability of wasting is approximately 20% among flood-exposed children, compared to 15% among those not exposed. By 24 months, these probabilities drop to roughly 14% and 12%, respectively, and by 48 months, the gap narrows further, with flood-exposed children having predicted probabilities of about 8% compared to 7% among their unexposed peers. These findings highlight that early life is a period of heightened nutritional vulnerability, during which the adverse effects of floods are most pronounced, gradually attenuating as children age.

(insert Figure 1)

I next examine whether maternal education moderates the adverse effects of flooding on child nutrition. Figure 2 presents predicted probabilities of wasting by flood exposure and maternal education, highlighting that education offers a modest but important protective effect. Among children not exposed to flooding, the predicted probability of wasting is about 10.8% for those whose mothers have no education, compared to 10.0% for those with some education. Following flood exposure, the predicted probabilities of wasting increase for all children, but the maternal education gap persists. Specifically, children of mothers with no education face a 13.1% probability of wasting, while those with educated mothers face a lower likelihood of approximately 10.8%. These results indicate that maternal education not only improves baseline nutritional outcomes but also helps buffer the negative consequences of environmental shocks.

(insert Figure 2)

In addition to examining child age and maternal education, I also tested several alternative interaction models, not shown here. Unsurprisingly, I found no gender difference in the nutritional impacts of flooding. This is consistent with current research in Africa, which has shown that gender disparities in childhood differences are generally modest and context specific. When examining the varying effects of flooding on maternal employment, I found a modest difference. Specifically, among children of unemployed mothers, the predicted probability of wasting was 12.0% compared to 12.5% among those of employed mothers. This small difference between children of unemployed and employed mothers may reflect a potential difference in the time devoted to caregiving, where employed mothers may be unable to dedicate as much time to caregiving during crises, although the difference in effects is modest. In this paper, I also investigated whether household wealth moderates the impact of flooding. Contrary to assumptions that wealthier families are better able to buffer shocks, I found no statistically significant differences across wealth categories, after controlling for childhood, maternal and household characteristics, suggesting that economic standing alone does not shield children from the acute nutritional consequences of floods. Finally, I tested for differences by rural versus urban residence. Here, too, I found no significant moderation effect.

While once primarily impacted by droughts, current findings suggest that flooding in West Africa will increasingly become a public health issue, having a detrimental immediate and potentially long-term impact on children's nutritional health. The results presented in this paper provide evidence that flood exposure has adverse effects on children's nutrition, particularly in terms of acute malnutrition. The declines in WHZ and increases in wasting highlight the heightened vulnerability of young children to environmental shocks. Moreover, these findings suggest that recent floods may play an important role in shaping children's nutritional vulnerability, posing heightened risks of illness, developmental delays, and mortality in affected populations. Moving forward, to address the risks, governments should proactively implement nutritional care policies and programs for children in the aftermath of floods, while also strengthening health systems to absorb future shocks. Alongside these policies and programs, emergency responses should extend beyond immediate relief to prioritize rehabilitative and nutritional support, helping to mitigate both the short-term effects of acute malnutrition and the longer-term developmental harms associated with repeated exposure to floods.

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Table 1: Summary of variables [weighted]

Variables	Mean	SD	Min	Max
Outcomes				
Wasted (WHZ <-2)	0.11	0.31	0.00	1.00
Weight for height z-score	-0.41	1.39	-5.00	5.00
Childhood Flood Exposure				
Flood Exposure in the last 12 months	0.33	0.47	0.00	1.00
Control Variables				
Childhood Characteristics				
Age (0-59 months)	28.13	17.21	0.00	59.00
Sex = Female	0.49	0.50	0.00	1.00
Child's birth order	3.75	2.43	1.00	18.00
Number of coresident children under five	2.55	1.64	0.00	27.00
Maternal Characteristics				
Mother's age (years)	29.45	6.92	15.00	49.00
Mother's education				
No education	0.63	-	-	-
Primary	0.18	-	-	-
Secondary +	0.19	-	-	-
Mother's employment				
Unemployed	0.35	-	-	-
Non-Agriculture Sector	0.42	-	-	-
Agriculture Sector	0.23	-	-	-
Household Characteristics				
Household wealth				
Low	0.43	-	-	-
Middle	0.20	-	-	-
High	0.36	-	-	-
Place of residence				
Rural	0.67	0.47	0.00	1.00
Sample size:	270,850			

Note: Weighted descriptive statistics.

Table 2: Impact of recent flood exposure on child nutritional growth.

	Model 1		Model 2	
Variables	WHZ		Wasting	
Recent flood exposure	-0.11	***	1.20	***

	(0.01)		(0.03)	
Age in months	0.00	***	0.98	***
	(0.00)		(0.00)	
Childhood controls	Yes		Yes	
Maternal Controls	Yes		Yes	
Household Controls	Yes		Yes	
Year fixed effects	Yes		Yes	
Provincial fixed effects	Yes		Yes	
Observations	270,834		270,834	

Robust standard errors are in parentheses. Weighted analyses.
*** p<0.001, ** p<0.01, *
p<0.05, † p<0.1

Figure 1: Predicted Probability of Wasting by Age Based on Flood Exposure

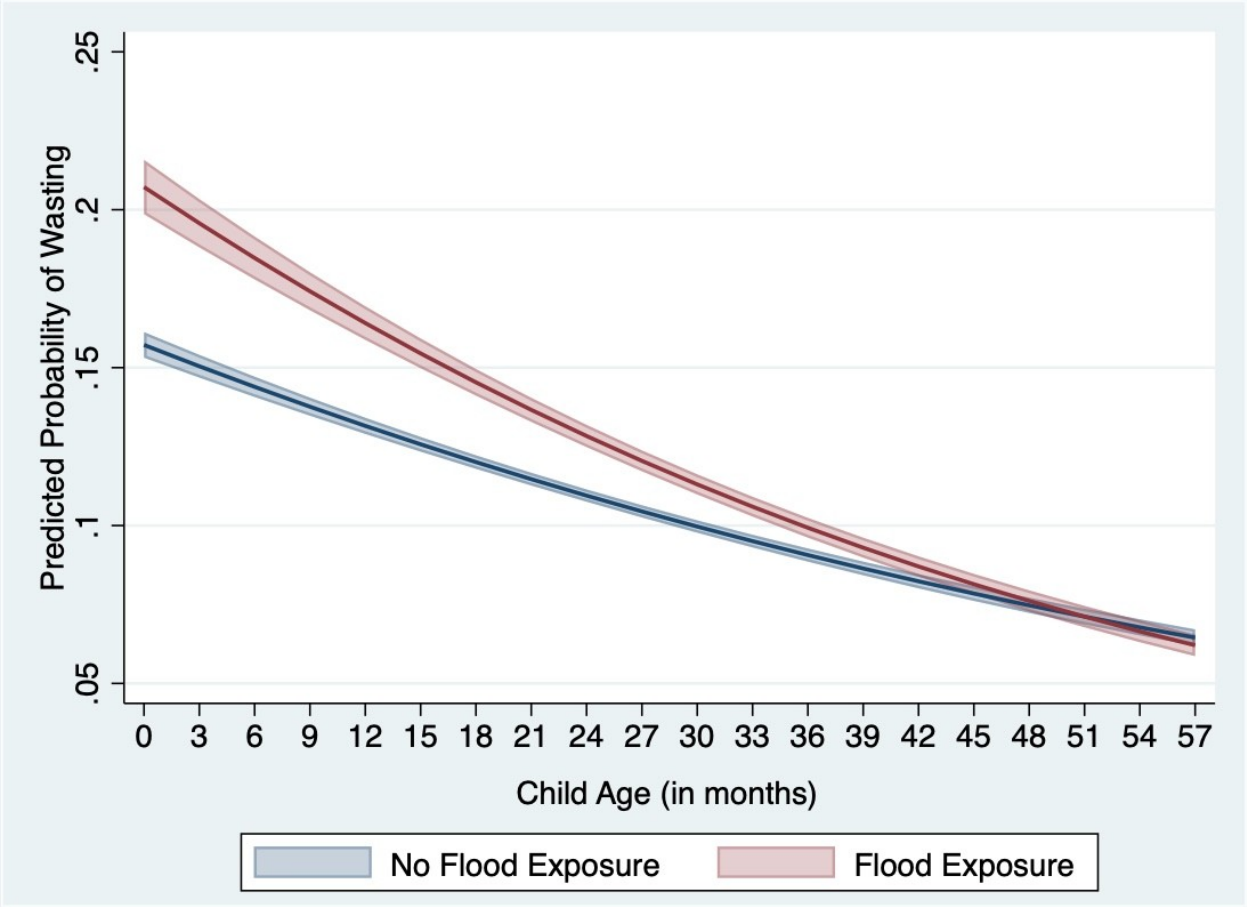

Figure 2: Predicted Probability of Wasting by Maternal Education Based on Flood Exposure