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Lifetime cumulative rainfall and the risk of chronic undernutrition in Burkina Faso

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MF HD

Background

- Chronic undernutrition affects 1 in 4 children and contributes to the high rate of under five mortality (88/1000 live birth)
- Immediate Causes: Poor dietary intake and recurrent illness
- Consequences: reduced cognitive skills, low school performance, lower adulthood productivity and economic output.
- Chronic undernutrition is expected to increase due to climate induced weather variability.

Rainfall variability in Burkina Faso

LONG-TERM ANALYSIS OF CLIMATE DATA IN BURKINA FASO (1950–2013)

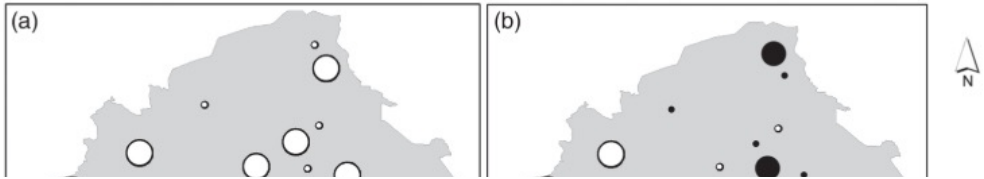

Table 6 Changes in the characteristics of the rainy season between 1971–2000 period and 2021–2050 period from the RCMs simulations

	CCLM	HadRM3P	RACMO	RCA	REMO
Date of season onset (days)	***+8.6***	+0.5	+0.5	−0.3	+2.4
Date of end of season (days)	+3.5	***+8.4***	***+6.1***	+5.9	+6.8
Season duration (days)	***−7.9***	+3.6	+3.0	+3.7	+0.8
Number of rain days (days)	***−7***	+0.4	+1.3	−3.1	−2.1
Mean daily rainfall (mm/d)	+0.1	+0.6	***+0.7***	−0.1	+0.3
Maximum daily rainfall (mm/d)	−0.6	+7.8	***+19.0***	−1.8	+2.1
Average length of dry spell (days)	***+0.2***	+0.1	***+0.2***	+0.1	+0.1

The values represent the difference between the averages over the two periods. Bold and italics: significant change from Wilcoxon test

2. Trends in (a) TOTR, (b) SDII, (c) CDD and (d) CWD in Burkina Faso over 1950–2013. [N: negative trend; P: positive tren
non-significant ($p > 0.05$); S: significant ($p \geq 0.01$ and ≤ 0.05]; VS: very significant ($p < 0.01$)].

Florence De Longueville et al. 2016; Ibrahim et al. 2014

What do we know?

- Many studies have looked into linkages between rainfall and undernutrition; yet there is still much to be understood in terms of the rainfall characteristics and timescales relevant for examining undernutrition (Phalkey et. al 2015; Cooper et al 2019)
- Common rainfall characteristics studied are mean annual precipitation (Akresh et al. 2011; Grace et al. 2012; Huss-Ashmore and Curry 1994) and deviations from long-term norms (Alderman 2010; Chotard et al. 2011; Rodriguez-Llanes et al. 2011).
- Still under debated: timescales at which rainfall variability and shocks are most relevant to child undernutrition
  - Early-life rainfall (Alderman 2010; Rodriguez-Llanes et al. 2011)
  - Prenatal rainfall (Woldehanna and Lives 2010)
  - Rainfall shocks in recent seasons (Skoufias and Vinha 2012)
  - Rainfall extremes in any single year (Alderman 2010)
  - Multi-year rainfall (Grace et. Al. 2012; Cooper et al 2019)

- Gap: Rainfall measured cumulatively in a child's lifetime (from conception to present age)
- Research Question:
  - Is there an association between cumulative rainfall exposure in child's lifetime and current height-for-age score?
  - Is the variation in association in terms of age, sex and socioeconomic status
- NASA satellite and model-based village-level daily rainfall data (resolution of 0.5^0 latitude by 0.5^0 longitude)(2011-2017)
- 2017 household survey with 12,054 children from 8000 households, 526 villages, 24 districts and 6 regions.
- Multilevel mixed linear model - Four level (individual-household-village-district)

Variable Description

- Outcome variable: Height-for-age z-score
- Exposure variable: Lifetime cumulative rainfall (mm) measured as the aggregated daily rainfall over the child's lifetime from the month of conception to present age at the data collection.
- Covariates: Child characteristics – age and sex; Caregiver characteristics - age, sex, marital status, literacy level; Household characteristics – household size, household wealth index, proximity of household to health facility

Image credit: http://patricerenard.com/williamdaniels/work/stories/mauvaisair/

RESULTS

Table 1: General characteristics of the study population

	Mean / Proportion	SD	Min	Max	N
Outcome variable					
Height (cm)	81.63	14.56	30	120	12054
Child age (Months)	26.53	17.88	0	59	12054
Stunted (%)	23.88				2878
Height-for-age zscore	-0.99	1.54	-5.99	5.96	12054
Exposure variable					
Lifetime cumulative rainfall (mm)	2644.27	1385.49	189.33	6412.48	12054
Standardised Lifetime cumulative rainfall	0.12	0.92	-1.52	2.63	12054
Covariates					
Child sex (Male %)	49.34				5947
Caregiver age (Years)	28.87	7.09	15	84	12040
Caregiver sex (Female %)	99.44				11974
Caregiver marital status (Married %)	98.15				11817
Caregiver literacy (Literate %)	19.14				9735
Household size	7.93	4.04	1	30	12023
Wealth index	0.09	0.95	-2.23	3.77	12054
Distance to Health Facility (Km)	5.34	7.82	0.02	259.33	12054

Table 2: Adjusted multilevel regression estimating the relationship between standardized Lifetime cumulative rainfall and height-for-age zscore. Stratification by age and sex.

	Main model		Age (months) stratified model				Sex stratified model			
			0-23		24-59		Male		Female	
Height-for-age zscore	**b**	**se**	**b**	**se**	**b**	**se**	**b**	**se**	**b**	**se**
Standardized Lifetime cumulative rainfall	-0.35***	0.07	-0.90***	0.14	-0.15**	0.08	-0.21**	0.10	-0.45***	0.09
Constant	-0.72***	0.16	-0.19	0.25	-2.41***	0.20	-0.65***	0.21	-0.15	0.20
N	12009		6055		5954		5924		6085	

Adjusted for Child characteristics – age and sex; Caregiver characteristics - age, sex, marital status, literacy level; Household characteristics – household size, household wealth index, proximity of household to health facility

b=coefficient; se= standard error; P-value * 0.10 ** 0.05 *** 0.010; N=Study population

Table 3: Adjusted stratified multilevel regression results estimating the relationship between standardized Lifetime cumulative rainfall and height-for-age zscore .

	Wealth Quintile Stratified models									
	Q1		**Q2**		**Q3**		**Q4**		**Q5**	
Height-for-age zscore	b	se	b	se	b	se	b	se	b	se
Standardized Lifetime cumulative rainfall	-0.22	0.14	-0.30**	0.15	-0.48***	0.14	-0.43***	0.14	-0.20	0.14
Constant	-0.62*	0.33	-0.38	0.35	-1.21***	0.37	-0.60	0.37	-0.77**	0.36
N	2378		2412		2401		2411		2407	

Adjusted for Child characteristics – age and sex; Caregiver characteristics - age, sex, marital status, literacy level; Household characteristics – household size, household wealth index, proximity of household to health facility

b=coefficient; se= standard error; P-value * 0.10 ** 0.05 *** 0.010; N=Study population

DISCUSSION

- We posit that the observed negative association between lifetime cumulative rainfall and HAZ score suggest a hazardous rainfall effect on food security and/or accumulated net negative disease effect.
- The differences in effect between boys and girls might suggest inequitable distribution of household resources.
- Household in between the lowest and uppermost quintile usually overlooked might be the worst affected by increasing rainfall variability.

Policy implication

- Focus on building household resilience against increased rainfall variability through nutritional, agricultural, health and sanitation interventions.
- Livelihood and nutritional support to cope with climatic shocks should be designed to capture more households likely to suffer from such effects.