Infant Mortality in West Africa: The Role of Climate

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Introduction

According to the United Nations Children's Fund (UNICEF), there has been much global reduction in infant deaths within the first 12 months of life. Global infant mortality rate in 2013 was 34 per 1,000 live births compared to 63 per 1,000 live births in 1990, an improvement of over 40% in 25 years. However, the countries with the highest rates of infant mortality are still in Sub-Saharan Africa: at 61 per 1,000 live births (1 in 16), it is more than 12 times the average in developed regions. In Mali, it's much worse than even by Sub-Saharan Africa standard: 78 per 1,000 live births (1 in 13).

How can the weather affect infant mortality in Mali? The climate in Mali is highly favorable to transmission of vector-borne diseases and heat wave, as well as food insecurity due to rainfall variability. Increased weather variability could affect the prevalence of communicable diseases as well as agricultural output in rural areas. Furthermore, an increase in heat-related mortality due to climate variability is well-documented in public health literature.

The current work examines how infant health is affected by different weather channels in Mali. We investigate the weather effects on an infant's survival around the time of child birth. Then, we analyze how the impact of weather could be mitigated by individual, parental and household characteristics.

Objectives

Our conceptual model is based on the collective household consumption allocation model developed by Han and Foltz (2015, unpublished). It is a household utility maximization model subject to the inter-temporal budget constraint, with weather shocks as exogenous variables affecting survival function of each individual. Incorporating insights from previous literature on child health, we expect to see the following effects of weather and child, parental and household characteristics on an infant survival:

Test 1: *As rainfall amount before birth increases, it affects the survival probability of an infant.*
Test 2: *As average temperature during the dry season increases, it decreases the survival probability of an infant.*
Test 3: *There are heterogeneous weather effects on an infant's survival depending on an infant's birth season.*
Test 4: *There are heterogeneous weather effects on an infant's survival depending on an infant's residency.*
Test 5.1: *An infant being a male can mitigate the effect of weather on an infant survival.*
Test 5.2: *Higher educational attainment by parents can mitigate the effect of weather on an infant survival.*
Test 5.3: *Living in a polygynous household can amplify the effect of weather on an infant survival.*

Method

- The analysis uses two data sources:
  - Demographic Health and Survey (DHS) data from 1996, 2001 and 2006 in Mali as a repeated cross-sectional dataset.
  - Climate Hazard group InfrRed Precipitation with Station (CHIRPS) data on rainfall and temperature, mapped with each cluster in DHS dataset.
- Sample size: 23,028 infants in 408 clusters (49 cercles), born between 1992 and 2006
- Empirical framework: loglogistic accelerated failure time (AFT) parametric survival model:

$$\ln(t_{ij}) = \beta T_{jt_i} + \chi Z_{ijt_i} + \gamma T_{jt_i} \times Z_{ijt_i} + \alpha_j + \tau_t + \sigma u_j$$

t_{ij}: Survival time t for infant i cercle j
T: Weather conditions (rain and temp)
Z: infant, parental and HH characteristics
α: Cercle fixed effect
τ: Time trend
σ: Shape parameter
u: Error term (clustered at cercle level)

Results

Figure 1. Histogram of Birth & Death of Infants by Month in Mali

There are more births toward the end of the dry season, whereas infant deaths are more evenly distributed.

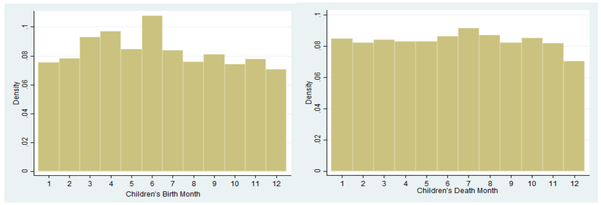

Figure 2. Rainfall by Month (April-Oct) in Mali (lpoly smoothed)

Rainfall ≥100mm monthly in June-September (Rainy/Growing Season) and increasing over the years.

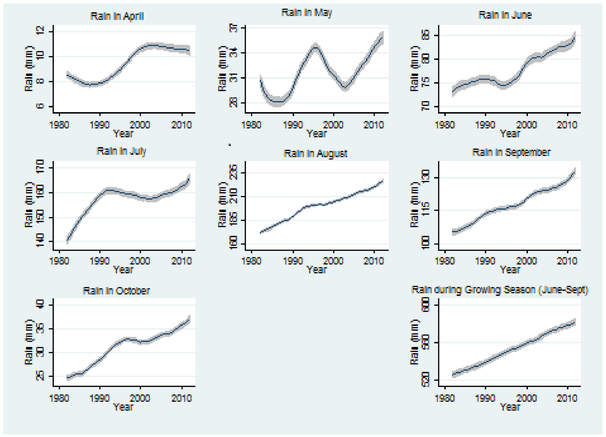

Figure 3. Average Temperature during Dry (left) and Rainy/Growing (right) Seasons in Mali (lpoly smoothed)

There is a slight increase in average temperature during dry and rainy seasons over the years.

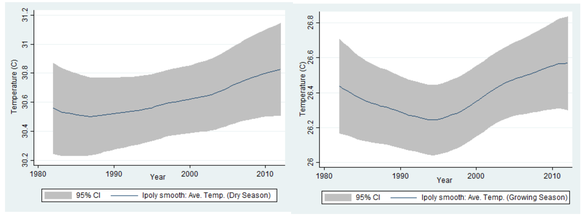

Table 1. Effects of Weather on Infant Survival, by Residence

1 S.D. (240mm)increase in rainfall amount during rainy season decreases infant survival by 5% in rural areas.
1 S.D. (1.4ºC) increase in average temperature during dry season decreases infant survival by 14.3% in rural areas.

Dependent Variables:	ALL	Rural	Urban
ln(survival time)	(1)	(2)	(3)
Weather Variables			
Average Temperature,	-0.0635**	-0.104***	0.101
Previous Dry Season	(0.0274)	(0.0322)	(0.0776)
Average Temperature,	0.00664	0.0227	-0.0548
Previous Rainy Season	(0.0361)	(0.0383)	(0.102)
Total Amount of Rainfall,	-0.000228**	-0.000209**	-0.000368
Previous Rainy Season	(0.000100)	(0.000105)	(0.000331)
Total Amount of Rainfall, Squared	8.78e-07	6.28e-07	2.29e-06
Previous Rainy Season	(7.07e-07)	(6.99e-07)	(2.13e-06)
Observations	253,461	192,063	61,398

1.All models include child, parental and household characteristics, cercle fixed effects and year trend. All errors are clustered at the cercle level.
2.***Statistical significance at 1% level, **at 5% level, *at 10% level

Table 2. Effects of Weather on Infant Survival, by Birth Season

There are significant prenatal weather effects on infant health. Children born during rainy season are affected by the heat stress prior to their birth. Children born during harvest season are affected by the rainfall prior to their birth.

Dependent Variables:	Rainy	Harvest	Dry
ln(survival time)	(1)	(2)	(3)
Weather Variables			
Average Temperature,	-0.127**	0.0351	-0.0874*
Previous Dry Season	(0.0516)	(0.0565)	(0.0484)
Average Temperature,	-0.00827	0.106	-0.0476
Previous Rainy Season	(0.0659)	(0.0646)	(0.0537)
Total Amount of Rainfall,	-0.000151	-0.000319*	-0.000229
Previous Rainy Season	(0.000162)	(0.000188)	(0.000157)
Observations	86,211	78,112	89,138

1.All models include child, parental and household characteristics, cercle fixed effects and year trend. All errors are clustered at the cercle level.
2.***Statistical significance at 1% level, **at 5% level, *at 10% level

Table 3. Interaction between Average Temperature (Dry Season) and Child Gender and Mother's Characteristics

Living in a polygynous household worsens the negative effect of heat stress on infant survival.

Average dry season temperature interacted with	(1)	(2)	(3)	(4)
Mother's education	0.0260			
	(0.0419)			
Mother's bargaining power		-0.0229		
		(0.0285)		
Polygyny			-0.0472***	
			(0.0148)	
Child is female				0.0295
				(0.0282)
Observations	253,461	253,461	253,461	253,461

1.All models include weather effects, child, parental and household characteristics, cercle fixed effects and year trend. All errors are clustered at the cercle level.
2.***Statistical significance at 1% level, **at 5% level, *at 10% level

Conclusion

We find evidence that weather conditions affect infant mortality, both in terms of rainfall and temperature. However, stratified analyses indicate that these findings are driven by heterogeneity in our data, such as residency and seasonality of child birth.

The analysis indicates that as the total amount of rainfall increases, an infant's survival probability decreases. While we cannot separate their individual effects on agriculture and disease environment, we observe that the total effect of an increased rainfall is negative on an infant's survival. We also find that as the heat stress during the dry season increases, an infant's survival probability decreases.

We find that weather conditions preceding birth have statistically significant effects on infant mortality. This affirms that a pregnant mother's health is an important factor in an infant's health.

We find that for infants in rural areas, living in polygynous households could actually worsen the negative effect of heat stress. When weather shocks affect the entire household, co-wives would try to use limited household resources for their own children's health first, creating conflicts among them.

With infants in rural areas especially vulnerable to weather effects, healthcare in rural communities should take a priority in public health policy debates in mitigating infant deaths in the future.

Contacts

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