Mother's Primary Education, Literacy Skills, and Infant Mortality in sub-Saharan Africa[1]

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Mothers' formal schooling—even at the primary level—is associated with lower risk of infant mortality (Basu and Stephenson 2005). There is less agreement about why this is the case. The fact that attending only a few years of primary school in childhood significantly increases the survival prospects of women's children in later life remains puzzling. This study will focus on the salience of one mechanism that has received limited attention in demography: reading skills.

A growing body of education research suggests that reading skills—a key subcomponent of broader literacy and language skills—may have profound implications for individuals' own, and their children's, wellbeing. At the most rudimentary level, being able to read is an incredibly practical skillset that affords individuals the ability to access, gather, and record information, and enables them to both convey and process written and spoken language more effectively (LeVine 2012). Beyond these practical functions, reading skills have cognitive benefits (Nicolopoulou and Cole 1999; Uhry and Ehri 1999). Individuals who can read display higher deductive reasoning, categorization, visuospatial discrimination, numeracy, and abstract speech compared to those who cannot read (Abadzi, Crouch, Echegaray, Pasco, and Sampe 2005), and a growing body of research demonstrates that cognitive skills function as a "social vaccine" by leading individuals to adopt healthier behaviors and avoid health-related risks (Herd 2010; Peters, Baker, Dieckmann, Leon, and Collins 2010). The appreciable nature of possessing reading skills also makes the skillset an important source of social status and power. Particularly in contexts where the skillset is rare, the status and class symbolism of being a "literate person" is likely to enhance individuals' perceptions of themselves, others' perceptions of them, and ultimately their social relationships, each of which is associated with superior health (Mirowsky and Ross 2003).

Emerging evidence from two West African countries confirms that mothers' reading skills are associated with child wellbeing, and have important implications for how we understand the protective effect of mothers' primary education. Mothers' reading skills improve child nutrition in Morocco (Glewwe 1999) and significantly lower the risk of child mortality in Nigeria (Smith-Greenaway 2013). Furthermore, in the Nigerian context, mothers' reading skills *fully* explains the survival advantage associated with mothers' primary education. Although these country-specific studies provide valuable insight into the child health benefits of mothers' reading skills, they are limited to two West African contexts wherein reading skills are exceptionally rare among women—even compared to other sub-Saharan African countries. Thus, it remains unknown whether mothers' reading skills are a key determinant of child wellbeing across the full spectrum of sub-Saharan Africa's diverse literacy contexts.

The centrality of mothers' reading skills for child wellbeing could vary across the subcontinent's distinct literacy contexts. Extending beyond conceptualizations of literacy as an individual skillset, female literacy may represent a shared community resource that spills over to benefit *all* children's health—regardless of their own mother's reading skills. Moreover, building on evidence that community characteristics moderate the effect of educational resources on child health at the household-level (Sastry 1996), it is possible that the level of female literacy in a child's community may condition the possible health benefits of having a mother who can read. For example, if living in a setting with higher female literacy spills over to benefit all children, it may substitute for having a mother who cannot read—thereby dampening the potential influence of children's own mothers' reading skills on their health. Conversely, living in a context with higher female literacy could complement the potential benefits of having a mother

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who can read, thereby exacerbating health disparities between children whose mothers can read versus those whose mothers cannot.

This paper will make two distinct contributions to the nascent literature on the child health benefits of mothers' reading skills. First, the paper will clarify whether mothers' reading skills significantly mediates the child health benefit of mothers' education across 30 sub-Saharan African countries. Second, the paper will demonstrate the sizeable heterogeneity in women's literacy across the subcontinent's provinces, and leverage this variability to explore whether living in a setting with higher female literacy (1) benefits child health above and beyond children's own mothers' reading skills and/or (2) moderates the benefits of having a mother who can read.

Before describing the data and sample, it is important to clarify that the current study focuses on the survival advantage of mothers' education and reading skills among children with primary educated mothers. Why is focusing on this subsample of children important? In sub-Saharan Africa, most reproductive age women who have gone to school discontinue their education at the primary-level. Thus, understanding the child health benefits of low levels of formal education will provide insight to the experience of the "typical" African mother. Furthermore, although policies increasingly recognize the importance of continuing formal education through adolescence, the current global focus is increasing access to primary education in low-income regions, thereby heightening the importance of understanding the components of primary education that can contribute to population health.

Data and Sample
The Demographic and Health Survey (DHS) is one of the only nationally representative surveys that directly evaluate individuals' reading skills alongside formal education and health information in low-income contexts, providing an unprecedented opportunity to consider their unique health benefits.[2] Because the DHS collects nearly identical data on mothers' education, reading skills and infant mortality across sub-Saharan Africa, I am able to harmonize and leverage these data for multinational use. I pool data from the 30 sub-Saharan African countries where the DHS was collected between 2000 and 2010.[3] Because I find that the proportion of literate women varies tremendously within and between sub-Saharan African countries, I use subnational provinces as the contextual unit of focus. To characterize the 270 provinces in my sample, I make use of DHS data from the women's, men's, and household questionnaires[4].

I make three restrictions to the analytic sample. First, to minimize recall error for birth and death reports and to ensure that current family characteristics (discussed below) correspond reasonably well with the child's environment since birth, I limit the sample to children born within the five years previous to the survey. Second, I exclude children whose mothers ever attended secondary school both because the theoretical focus of this paper is on primary educated mothers, and because the DHS did not administer the reading assessment to these women. Third, I use listwise deletion to handle the 3 % of children with missing data, resulting in a final analytic sample of 194,398 children in 270 provinces in 30 sub-Saharan African countries. Table 1 provides detailed information on the countries and samples of children.

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[2] I am aware of only two additional nationally representative surveys in developing countries that include direct assessments of literacy before the DHS: the 1990-91 Moroccan Enquete Nationale des Niveaux de Vie des Menages (ENNV) collected in Morocco (see Glewwe 1999) and the 1994 Project for Statistics on Living Standards and Development collected in South Africa (see Thomas 1999).

[3] Of the 48 countries in the sub-Saharan African region, I exclude the 13 countries where the DHS was not collected during the time period, and the 5 countries where the data are not public, resulting in a final analytic sample includes the following countries: Benin (2006), Burkina Faso (2003), Burundi (2010), Cameroon (2004), Chad (2004), Congo—Brazzaville (2005), Democratic Repulic of the Congo (2007), Ethiopia (2005), Gabon (2000), Ghana (2003), Guinea (2005), Kenya (2003), Lesotho (2009), Liberia (2007), Madagascar (2003/04), Malawi (2004), Mali (2006), Mozambique (2003), Namibia (2006-07), Niger (2006), Nigeria (2003), Rwanda (2005), Sao Tome Principe (2008), Senegal (2005), Sierra Leone (2008), Swaziland (2008), Tanzania (2004-05), Uganda (2006), Zambia (2007), Zimbabwe (2005-06).

[4] Given the large number of cases per region, I include the index-family when creating the region-level measures (described below) and confirm that this methodological choice does not alter the estimates.

Key Measures

Infant Mortality. The outcome variable is the hazard of mortality before age one. More specifically, the outcome is the risk of death between birth and one year (0-11 months) or between birth and the survey date in the case of children who were not yet one year old at the time of the survey. Of the 194,398 births, 14,163 children (7.2 %) died before their first birthday.

      Mothers' Primary Schooling. Respondents are asked to report the highest level of education that they completed. After restricting the sample to children whose mothers never attended secondary school, mothers' primary schooling ranges from 0 to 8 years.

      Mothers' Reading Skills. I measure reading skills using an interviewer assessment of whether respondents can read aloud in their preferred language one of four possible sentences: "Parents love their children," "Farming is hard work," "The child is reading a book," or "Children work hard at school." If the respondent did not read every word, the interviewer probed the respondent. Interviewers categorized respondents as unable (did not read any of the words), partially able (read some of the words in the sentence), or fully able (read all of the words in the sentence) to read.

      Province-level Female Literacy. I use the DHS's women's data file for each country to aggregate the percentage of women (15-49 years old – primary educated) in each province who can read (partially or fully) based on the reading assessment described above.

      Controls. I control for several indicators at both the child and province levels. Child-level controls include maternal age at the time of the focal child's birth (19 or younger, 20–34 [reference group], or 35 and older) , total sibship size (number of siblings with the same mother), the duration of the preceding birth interval (none: child is first birth [reference group], 24 months or less, and more than 25 months), gender (female=1), birth order, and whether the child is a multiple (=1). I control for household socioeconomic status using the DHS–constructed wealth index.[5] I also control for the number of household members, and whether the mother is Muslim (=1).

      Because the province's general level of development and access to infrastructure may confound the associations between province-level female literacy and infant survival, I use the women's data-file to create an indicator of the average level of formal schooling among adult women (15-49 years old), and use the household data-file to create indicators for the percentage of households in each region that the DHS lists as "rural" (versus "urban," see Kravdal and Kodzi for a similar approach) and an indicator of the percentage of households in each province that report having electricity (see Sastry 1996 and Kravdal 2002 for similar approaches).

Analytic Strategy

To estimate the risk of infant mortality, I use discrete-time hazard models, which are ideal for working with censored observations. Infants who are still alive at the end of the observation period or who have not reached their first birthday are right censored. In addition to the issue of censoring, the data are hierarchically structured: many infants share the same province and country. Thus, to address censoring and the hierarchical nature of the data, I estimate a series of random-effects discrete-time logit models. By including a dummy-variable for each country, I control for unobserved confounders at the country-level[6].

Preliminary Results

Table 1 shows descriptive statistics for the study sample. On average, children's mothers have attended fewer than two years of primary school. Whereas nearly 3 out of every 4 children have mothers who cannot read, approximately 10% of the children's mothers can read partially while nearly 20% of the children's mothers can read fully. In addition to demonstrating the sizeable variation in children's own

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[5] The DHS-constructed wealth index is an ideal measure for comparing socioeconomic status across countries (see Bollen, Glanville, and Stecklov (2007) and Houweling, Kunst, and Mackenbach (2003)).

[6] A country-level fixed effects approach allows me to control for constant, unobserved factors that vary across sub-Saharan African countries. Because a fixed-effects approach is less efficient, the analysis will yield more conservative estimates.

mothers' reading skills, there is tremendous heterogeneity in terms of female literacy at the province-level. Whereas nearly half of primary educated adult women are, on average, literate, this value ranges from less than 4 % of women in some provinces to nearly all of women in other provinces. The tremendous variation in the province-level female literacy further motivates exploration of how this diversity in context conditions the implications of children's own mothers' reading skills.

Table 2 demonstrates the study's three central findings: (1) mothers' reading skills *fully* explains the association between mothers' primary education and infant survival and (2) living in a province with higher female literacy benefits infant survival above and beyond children's own mother's reading skills; however (3) there is no evidence that female literacy dampens or exacerbates the implications of mothers' reading skills at the individual-level. Beginning with Model 1, corroborating prior findings, the results show that each level of mothers' primary education corresponds with a 1.4 % lower risk of infant mortality. Thus, compared to children whose mothers have never been to school, children whose mothers have attained six levels of primary education have an 8.4 % lower risk of infant mortality. Model 2 shows that, upon inclusion of mothers' reading skills, the inverse association between mothers' primary education and risk of infant mortality is reduced to non-significance. Thus, mothers' reading skills *fully* explains the survival benefit associated with having a mother who attained higher levels of primary school. Moreover, infants whose mothers have some reading skills experience a 13.1 % lower risk of mortality compared to those whose mothers have no reading skills while infants whose mothers can fully read have a 15.1 % lower risk of mortality compared to their peers whose mothers cannot read.

Model 3 demonstrates that focusing on reading skills at the individual-level underestimates the full potential of women's literacy to lower infant mortality in sub-Saharan Africa. The results show that net of children's own mothers' reading skills, each unit increase in the percentage of literate females in a child's province increases their likelihood of survival by 1 percentage point. Considering that female literacy ranges from less than 4% to 99%, the magnitude of this association is sizeable. Model 4 confirms that the infant survival benefit associated with living in a province with higher female literacy is robust to province-level controls for socioeconomic development and access to infrastructure.

Although living in a setting with a higher prevalence of literate females is associated with higher infant survival, the nonsignificant interaction terms in Model 5 demonstrate that there is no evidence that the literacy context in which children live moderates the survival benefits of their own mothers' reading skills. The association between mothers' reading skills and child survival appears to be a global one, unaltered by the broader literacy environment.

Future Directions

This study will significantly contribute to the growing evidence that mothers' reading skills are a central correlate of child health and survival in sub-Saharan Africa. Furthermore, by conceptualizing literacy as more than an individual skillset, this study will demonstrate the full scope of its child health benefits.

As I develop this paper, I will make minor methodological improvements that will further strengthen the results (e.g., test if results are consistent for under-five mortality, add additional controls). Further, I will broaden the paper's conceptual focus to explore additional contextual features that may moderate the health benefits of mothers' reading skills. A recent study demonstrates that the health benefits of mothers' reading skills are dependent on mothers' decision-making power (Smith-Greenaway Forthcoming). Thus, I will explore whether the gendered context conditions mothers' ability to utilize their reading skills in ways that produce salubrious health outcomes for their children. Furthermore, I will more broadly explore whether structural features—such as women's access to healthcare—condition the impact of mothers' reading skills on infant survival. Together, the results from this paper will demonstrate the unique child health benefits of women's reading skills at the family and contextual levels, and will highlight how broader social structures shape these processes.

Table 1. Descriptive Statistics

Variable	%/Mean (SD)	Range
Key Measures		
Level - 1 (Child)		
Mothers' Primary Schooling	1.91 (2.59)	0 - 8
Mothers' Reading Skills		
No reading skills	71.77	
Some reading skills	9.20	
Full reading skills	19.03	
Level - 2 (Province)		
Female Literacy	41.16 (29.31)	3.50 - 99.66
Controls		
Level - 1 (Child)		
Household wealth	-0.31 (0.73)	-3.09 - 8.76
Household size	7.45 (4.47)	1 - 18
Mother is muslim	41.96	
Mothers' age at child's birth (years)		
<20 years old	18.93	
21-34 (ref)	66.54	
35+	14.53	
Sibship size	4.39 (2.58)	0 - 18
Preceding birth interval (months)		
First born (ref)	18.17	
<24	46.74	
24+	35.09	
Female	49.48	
Birth order	3.99 (2.56)	1 - 18
Child is twin	3.39	
Level - 2 (Province)		
% Households Rural	71.11 (23.78)	0 - 100
% Electrified Households	19.79 (21.14)	0 - 98.62
Average Female Schooling	3.37 (2.54)	.25 - 9.49

Source: Demographic and Health Survey
N=194,398 children

Table 2. Multilevel Discrete Time Logit Hazard Models of the Associations between Female Literacy, Mothers' Primary Education, Reading Skills, and Infant Survival across 30 sub-Saharan African Countries

Variable	Model 1				Model 2				Model 3				Model 4				Model 5			
	OR	Coeff.	SE	Sig.	OR	Coeff.	SE	Sig.	OR	Coeff.	SE	Sig.	OR	Coeff.	SE	Sig.	OR	Coeff.	SE	Sig.
Level - 1 (Child)																				
Mothers' Primary Schooling	0.986	-0.014	0.004	**	1.005	0.005	0.006		1.004	0.004	0.540		1.002	0.002	0.006		1.002	0.002	0.006	
Mothers' Reading Skills																				
No reading skills (ref)																				
Some reading skills					0.869	-0.141	0.037	***	0.878	-0.130	0.001	**	0.882	-0.126	0.038	**	0.859	-0.152	0.073	*
Full reading skills					0.849	-0.164	0.037	***	0.855	-0.157	0.000	***	0.861	-0.150	0.038	***	0.901	-0.104	0.083	
Level - 2 (Province)																				
Female Literacy									0.994	-0.006	0.003	*	0.994	-0.006	0.003	*	0.994	-0.006	0.003	
Cross-level Interaction																				
Female Literacy * Mother has no reading skills (ref)																				
Female Literacy * Mother has some reading skills																	1.000	0.000	0.001	
Female Literacy * Mother has full reading skills																	0.999	-0.001	0.001	
Controls																				
Level - 1 (Child)																				
Household wealth	0.971	-0.030	0.013	*	0.974	-0.026	0.013	*	0.991	-0.009	0.540		0.999	-0.001	0.015		0.999	-0.001	0.015	
Household size	0.921	-0.082	0.003	***	0.921	-0.082	0.003	***	0.918	-0.085	0.000	***	0.918	-0.085	0.003	***	0.918	-0.085	0.003	***
Mother is Muslim	0.997	-0.003	0.025		1.001	0.001	0.025		1.004	0.004	0.895		1.013	0.013	0.028		1.013	0.013	0.028	
Mothers' age at child's birth (years)																				
<20 years old	1.081	0.078	0.027	**	1.078	0.075	0.027	**	1.063	0.061	0.024	*	1.063	0.062	0.027	*	1.063	0.062	0.027	*
21-34 (ref)																				
35+	1.311	0.271	0.031	***	1.311	0.271	0.031	***	1.332	0.287	0.000	***	1.332	0.287	0.031	***	1.332	0.286	0.031	***
Sibship size (0-18)	1.875	0.629	0.012	***	1.874	0.628	0.012	***	1.892	0.638	0.000	***	1.892	0.638	0.013	***	1.892	0.638	0.013	***
Preceding birth interval (months)																				
First born (ref)																				
<24	0.770	-0.262	0.029	***	0.769	-0.263	0.029	***	0.769	-0.262	0.000	***	0.769	-0.263	0.029	***	0.769	-0.263	0.029	***
24+	0.480	-0.735	0.032	***	0.480	-0.735	0.032	***	0.477	-0.740	0.000	***	0.477	-0.741	0.033	***	0.477	-0.741	0.033	***
Female	0.855	-0.157	0.017	***	0.855	-0.157	0.017	***	0.853	-0.159	0.000	***	0.853	-0.159	0.017	***	0.853	-0.159	0.017	***
Birth order	0.568	-0.566	0.013	***	0.568	-0.566	0.013	***	0.561	-0.578	0.000	***	0.561	-0.578	0.013	***	0.561	-0.578	0.013	***
Child is twin	3.282	1.188	0.030	***	3.285	1.190	0.030	***	3.346	1.208	0.000	***	3.345	1.208	0.030	***	3.345	1.208	0.030	***
Age in Month Dummies (not shown)																				
Level -2 (Province)																				
% Households Rural																				
% Electrified Households													1.000	0.000	0.001		1.000	0.000	0.001	
Average Female Schooling													0.995	-0.005	0.002	**	0.995	-0.005	0.002	**
													1.093	0.088	0.034	**	1.093	0.089	0.034	**
Level - 3 (Country)																				
Country dummies (not shown)																				
Random Effects																				

Level - 2									
Between-Family Variance	0.181	***	0.181	***	0.1705	***	0.1633	***	0.1633	***

Model Fit				
Log-likelihood	-70662	-70650	-70096	-70096	-70096

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