

A comparative multilevel analysis of community effects on child mortality in sub-Saharan Africa

Adébiyi Germain Boco

Simona Bignami

Introduction

Infant and child mortality in sub-Saharan Africa remain a major health problem, and the progress made during the past four decades has been unevenly distributed (Ahmad, et al., 2000; Garenne and Gakusi, 2006). While researchers have devoted considerable attention to the impact of individual-level factors on child mortality, less is known about how community characteristics and institutions affect health outcomes for children, even though they have a prominent role in theoretical models of child mortality (most notably, Mosley and Chen, 1984; Shultz, 1984, 1985). In addition, the incorporation of the role of the community in the analysis of child mortality provides an opportunity to highlight health risks associated with particular social structures and community ecologies, thus providing a policy tool for the development of public health interventions (Pickett and Pearl, 2001; Stephenson et al., 2006). In this paper, we use multilevel models to examine the impact of contextual factors on under-5 mortality risk for all sub-Saharan African countries with available data.

Studies carried out during the past two decades have increasingly used multilevel methods to examine the independent effect of contextual factors on child mortality as distinct from the more widely investigated individual factors. In particular, communities' educational and literacy levels have been found to have a strong effect on children's health outcomes (Desai and Alva, 1998; Kravdal, 2004; Parashar, 2005; DeRose and Kulkarni, 2005). The level of socioeconomic development also appears to have a positive effect on child health and nutritional status (Sastry, 1996; Kuate-Defo, 2001; Fotso and Kuate-Defo, 2005a, 2005b; Montgomery and Hewett, 2005; Ngnie-Teta, et al., 2007) as

well as access to health care and health infrastructure do (Andes, 1989, 1992; Macintyre et al., 2000; Pickett and Pearl, 2001; Matteson, et al. 1998)

The main weakness of the existing studies is their limited focus (a single country or region within a country) and the heterogeneity in the definitions adopted. Moreover, the still limited availability of community data that can be easily linked to individual-level data from household surveys hinders researchers' efforts to fully analyze community effects on child mortality. To address these issues, we use data from the latest round of Demographic Health Surveys for all countries in sub-Saharan Africa that include community-level information, and we systematically examine the impact of contextual factors on child mortality. Specifically, we use multilevel discrete-time event history analysis to assess the influence of community population size, average female education, access to medical facilities on the risk of dying before age 5. Our preliminary finding is that the introduction of community-level controls significantly reduces the impact of individual-level factors on child mortality in all contexts.

Data and methods

Data sources

We use data from the latest round of Demographic Health Surveys for all countries in sub-Saharan Africa that include community-level information. These are: Benin (2001), Chad (2004), Gabon (2000), Guinea (1999), Mali (2001), Mauritania (2000/01) and Nigeria (1999). Overall, the analysis concerns children born in 48539 families nested in a sample of 2047 clusters (communities).

Methods

We use multilevel discrete-time event history analysis (Allison, 1982; Singer and Willett, 2003) to analyze community-level effects on child mortality. The multilevel approach allows for correlation in mortality risks between children by including in the model a community/family-specific random effect.

The outcome variable of interest is the risk of death in childhood (0-59 months) measured as the duration from birth to the age at death, or censored. Due to the hierarchical nature of the data, a tree-level model is used in the analysis. Assuming a logit link between the hazard rate and the explanatory variable, the tree-level random-effects discrete-time hazard model can be expressed as:

$$\ln(h_{ijk}/(1-h_{ijk})) = \alpha_t + X_{ijk}\beta + \omega_{jk} + v_k,$$

where

h_{ijk} is the probability of dying before age 5, child referenced (i =child, j =household, k =cluster)

X_{ijk} is a vector of covariates corresponding to the i^{th} child of the j^{th} family in the k^{th} cluster, which may take on different values at different discrete times,

α_t is a function of time and is defined for age,

β is a vector of unknown regression parameters associated with the explanatory variables,

ω_{jk} is a residual error term associated with the j^{th} family in the k^{th} cluster, and

v_k is a residual error term associated with the k^{th} cluster.

Models are fitted using the MLwin software with Binominal, Predictive Quasi Likelihood (PQL) and second-order linearization procedures (Rasbash, et al., 2000; Goldstein, et al., 2002; Browne, et al., 2005;).

References

- Ahmad, O.B., A.D. Lopez, & M. Inoue. 2000. "The decline in child mortality: a reappraisal." *Bulletin of the World Health Organization* 78(10):1175-1191.
- Allison, P.D. 1982. "Discrete-Time Methods for the Analysis of Event Histories." *Sociological Methodology* 13:61-98.
- Andes, N. 1989. "Socioeconomic, Medical Care, and Public Health Contexts Affecting Infant Mortality: A Study of Community-Level Differentials in Peru." *Journal of Health and Social Behavior* 30(4):386-397.

- Andes, N. 1992. "Infant mortality and the community context in Peru." *Rev Peru Poblac*(1):81-106.
- Andrzejewski, C.S., H.E. Reed, & M.J. White. 2006. "Multilevel Analysis of Community Effects on Health Knowledge in Coastal Ghana: Evidence from the 2002 Ghana Population and Environment Survey." Presented at PAA 2006 Annual Meeting Los Angeles, CA.
- Browne, W.J., S.V. Subramanian, K. Jones, & H. Goldstein. 2005. "Variance partitioning in multilevel logistic models that exhibit overdispersion." *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 168(3):599-613.
- DeRose, L.F. & V. Kulkarni. 2005. "Community-Level Effects on Infant and Child Mortality in Zambia, with Special Attention to HIV Prevalence." Paper presented at XXV International Population Conference of the IUSSP, July 2005, Tours, France.
- Desai, S. & S. Alva. 1998. "Maternal Education and Child Health: Is There a Strong Causal Relationship?" *Demography* 35(1):71-81.
- Fotso, J. & B. Kuate-Defo. 2005a. "Measuring socioeconomic status in health research in developing countries: Should we be focusing on household, communities or both?" *Social Indicators Research* 72:189-237.
- Fotso, J.C. & B. Kuate-Defo. 2005b. "Socioeconomic inequalities in early childhood malnutrition and morbidity: modification of the household-level effects by the community SES." *Health Place* 11(3):205-225.
- Garenne, M. & E. Gakusi. 2006. "Health transitions in sub-Saharan Africa: overview of mortality trends in children under 5 years old (1950-2000)." *Bull World Health Organ* 84(6):470-478.
- Goldstein, H., W. Browne, & J. Rasbash. 2002. "Multilevel modelling of medical data." *Statistics in Medicine* 21(21):3291-3315.
- Kravdal, O. 2004. "Child mortality in India: the community-level effect of education." *Popul Stud (Camb)* 58(2):177-192.
- Kuate-Defo, B. 2001. "Nutritional status, health and survival of Cameroonian children: the state of knowledge." pp. 3-50 dans: B. Kuate-Defo (Ed), *Nutrition et santé des enfants au Cameroun/Nutrition and Child Health in Cameroon*: Westmount, Price-Patterson Ltd./Canadian Publishers.
- Macintyre, S., A. Ellaway, & S. Cummins. 2002. "Place effects on health: how can we conceptualise, operationalise and measure them." *Soc Sci Med* 55(1):125-139.
- Matteson, D.W., J.A. Burr, & J.R. Marshall. 1998. "Infant mortality: a multi-level analysis of individual and community risk factors." *Soc Sci Med* 47(11):1841-1854.
- Montgomery, M.R. & P.C. Hewett. 2005. "Urban Poverty and Health in Developing Countries: Household and Neighborhood Effects." *Demography* 42(3):397-425.
- Mosley, W.H. & L.C. Chen. 1984. "An Analytical Framework for the Study of Child Survival in Developing Countries." *Population and Development Review* 10(Supplement: Child Survival: Strategies for Research):25-45.
- Ngnie-Teta, I., B. Kuate-Defo, & O. Receveur. 2007. "Risk factors for moderate to severe anemia among children in Benin and Mali: Insights from a multilevel analysis." *Food and Nutrition Bulletin* 28(1):76-89.
- Parashar, S. 2005. "Moving beyond the mother-child dyad: Women's education, child immunization, and the importance of context in rural India." *Social Science & Medicine* 61(5):989-1000.

- Pickett, K.E. & M. Pearl. 2001. "Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review." *J Epidemiol Community Health* 55(2):111-122.
- Rasbash, J., W. Browne, H. Goldstein, M. Yang, I. Plewis, M. Healy, G. Woodhouse, D. Draper, I. Langford, & T. Lewis. 2000. *A User's Guide to MLwiN*. London: Institute of Education.
- Sastry, N. 1996. "Community Characteristics, Individual and Household Attributes, and Child Survival in Brazil." *Demography* 33(2):211-229.
- Singer, J.D. & J.B. Willett. 2003. *Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence*. New York: Oxford University Press, 644 p.
- Stephenson, R., A. Baschieri, S. Clements, M. Hennink, & N. Madise. 2006. "Contextual influences on the use of health facilities for childbirth in Africa." *American Journal of Public Health* 96(1):84-93.