Birth Month is Predictive of Child Health and Survival in Sub-Saharan Africa

EXTENDED ABSTRACT

1 Introduction

Motivation

Public health officials have long been aware of seasonal fluctuations in morbidity and mortality, and in response have taken measures to mediate the increases. In contrast, they have not paid much attention to another seasonal relationship: the influence of birth month on child health. The probability of dying before age one or during childhood is not always the same for children born during different months. In many settings, some months are associated with excess death and negative health outcomes.

Sub-Saharan Africa (SSA) has some of largest under-five mortality rates (U5MR)\(^1\) in the world— in 2008, there were 144 deaths per 1000 live births in SSA.(You et al., 2010) If there is a relationship between birth month and under-five mortality rates (U5MR) in SSA, then policies that help women conceive during optimal periods may help reduce U5MR. But the effectiveness of such policies would depend on the etiology of the birth month effect in SSA.

Possible explanations for birth month effects on health

Potential explanations for the birth month effect fall under the following three hypotheses: 1) births, within a year, may not be randomly distributed across the population, because, for instance, seasonal fecundability patterns\(^2\) vary by socioeconomic status;(Buckles and Hungerman, 2010) 2) individuals conceived in different months experience differential nutritional inputs and exposure to illness during the fetal period; 3) birth month is also associated with different postpartum exposures in terms of disease and nutrition.(Bengtsson and Lindström, 2003; Eastman, 1945)

\(^1\)U5MR is the probability of dying before age five expressed in terms of 1000 live births.

\(^2\)Determinants of fecundability such as monthly frequency of coitus, or monthly probability that a cycle is ovulatory may differ among different population subgroups.
Objectives

In this paper we describe, quantify, and analyze the relationship between birth month and child mortality and stunting in SSA using data from Demographic and Health Surveys. Specifically we aim to answer the following questions:

- Is there a relationship between birth month and under-five mortality?
- Is the relationship between birth month and neonatal, infant, and childhood mortality the same?
- Are months of higher/lower mortality risk also months associated with higher/lower probability of being stunted?
- What is the impact of controlling for individual, and family characteristics? Does it diminish the variation in mortality and development across birth months?

2 Data and Methods

Demographic and Health Surveys

Main variables. The data used in this study come from the Demographic and Health Surveys (DHS). The DHS are nationally representative surveys of women of childbearing ages (15-49) carried out in developing countries. We have data from 30 SSA countries, with one to five surveys for each country. The DHS datasets are well suited for conducting analysis of child mortality and health. In addition to complete reproduction histories (month and year of birth of each child a woman has ever had), each woman is also asked if the child is still living. And if the child has died, the age (in completed days, months, or years) of the child’s death is ascertained. Anthropometric measurements of height and weight for children under age five3 are also taken during the survey.

Covariates. The DHS also contains a wealth of data on individual and family characteristics, which may affect the relationship between birth month and child health and survival. These include information on sex, birth order number, short preceding birth interval, rural/urban classification, mother’s age at birth, mother’s education level, and religion.(Cleland and van Ginneken, 1988; Hobcraft et al., 1985; Miller et al., 1992; Mosley and Chen, 1984)

3For a few surveys anthropometric measurements are only taken of children under the age of three.
Estimation Strategies

Separate analyses are run for each of the 30 SSA countries.

**Survival Models.** Due to the discrete nature and censoring of our data, our survival analysis relies on flexible piecewise exponential hazard models (PWE) and shared frailty piecewise exponential hazard models to determine the association between birth month on mortality at different ages. The intervals over which we assume that the hazard is constant are: less than 1 month, 1 to 5 months, 6 to 11 months, 12 to 23 months, 24 to 35 months, 36 to 47 months, and 48 to 59 months. We first use a piecewise model with age intervals and birth month to generate hazards for each combination of birth month and age interval. The resulting hazards are used to calculate survival probabilities as well as the under-five mortality rate (U5MR). Next we test whether the interactions between the month of birth and age interval are significant. Finally, we sequentially control for sets of individual characteristics (birth order, sex, birth interval) and maternal and family characteristics (mother’s age at birth, mother’s education level, rural versus urban residence), and analyze the effect on the birth month coefficients. The model with the controls for maternal characteristics is a shared frailty model, therefore we are also able to control for unobserved characteristics associated with having the same mother.\(^4\)

We test for the effects of interactions between month of birth and age intervals because the impact between birth month and mortality at different ages may not to be the same across different months.\(^{(Breschi and Livi-Bacci, 1997; Eastman, 1945; Muñoz-Tudurí and García-Moro, 2008)}\)

**Logit models.** To analyze the birth month effect on stunting, we rely on anthropometric measurements taken at the time of the survey. We limit the samples to observations under the age of three at the time of survey. We use logit models to determine the odds of being stunted controlling for birth month, sex, birth order, and age. We then control for maternal and family characteristics using a random effects logit model, with mother as the random intercept. The additional controls are mother’s level of education, urban versus rural residence, and mother’s age at birth. The random effects allow us to control for additional unobserved family characteristics. The equations for the logit models are in the Appendix. From the logit models, we calculate both odds ratios where the reference is the birth month associated with the highest predicted probability of being stunted.

Unlike in the survival model, this sample only includes children who are alive at the time of

\(^4\)Equations for the survival models are located in the Appendix.
the survey. Consequently, the results we find for stunting could be biased by the exclusion of those who experience mortality, especially when child mortality is high. In the presence of heterogeneity, weaker children may die earlier if born in low survival months therefore the remaining children in low survival month may be more robust; leading to opposite birth month effects for stunting compared to survival.

3 Results

Survival. A child’s birth month has a statistically significant influence on the probability of surviving to age five in the majority of SSA countries. The birth month effects on the probability of surviving to age five (conversely the probability of dying by age five (U5MR)) are large (Table 1). On average, U5MR in the worst birth months are 39% higher than the U5MR in the best birth month. In Sierra Leone, Ivory Coast, and in Zimbabwe the differences were greater than 60%. According to the model, if all children were born during the best survival month, the overall U5MR would substantially decline.

Stunting. Birth month is also correlated with the odds of being stunted, in SSA. On average there was a 9 percentage point difference between the predicted probability of an average child being stunted if born in the worst versus best month (max = 14 %, min = 4 %). This birth month effect is comparable to the effect of sex and birth order on odds of being stunted.

4 Discussion and Conclusion

In SSA, birth month is predictive of early life outcomes. There are large and significant differences between the probability of dying by age five by birth month. There are also large and significant differences between birth months on the probability of being stunted if under age three. The birth month effects are often larger than the effects of known risk factors for child mortality and stunting. In the majority of the SSA countries the birth month effect is relatively constant across different age intervals. There appears to be some geographic

5Predicted probabilities estimated at the mean of sex, birth order, and age.
clustering in the pattern of the birth month effect indicating that environmental factors may be playing a role. In a few countries there is some potential evidence of selective survival, as the birth month effect was reverse when comparing results for survival and stunting. Controlling for socio-demographic factors did not attenuate the birth month effect on child health. A likely explanation is that in SSA the birth peak often occur in months associated with high survival.

References


