Estimating child and infant mortality in Egypt through a Bayesian approach for small area

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Abstract

In the Egyptian context, delayed fertility transition compared to neighboring countries, can be in part ascribed to the delay in the fall of infant mortality rates. Infant mortality was high in Egypt till the 1980s. Since then, infant mortality recorded significant progress: in 2001, the number of deaths per 1000 births was 38 against 97 in 1984. However differences are still significant between governorates: in urban governorates, the 2008 level is 29 deaths per 1,000 births. In rural Upper Egypt, mortality was about 39 ‰. No previous studies had attempted to estimate infant and child mortality in Egypt for small geographical areas. Strong socio-economics differences and inequalities exist between urban and rural setting, Upper and Lower Egypt and even between small area in the same region or city. Those differences justify the need to calculate infant and child mortality rates at the local level. We will account for this problem using a Bayesian hierarchical model for small area: model-based estimators will be derived and their precisions compared with alternative estimators proposed in literature. We use data from Egyptian Demographic and Health Surveys (1995 and 2005), Egyptian population register and Egyptian Population and Housing Census (1996 and 2006).

Introduction

The level of infant and child mortality is a good indicator of health status in Egypt (UNDP, 2004). Indeed, the infant mortality rate is a major component of overall mortality and life expectancy at birth. Although overall mortality in Egypt has declined since the mid-nineteenth century, infant mortality remained very high for a long time. It was above 300 ‰ until the late 1930s and in 1945 it was still 255 ‰ (Fargues, 2002). Figure 1 shows estimates of the infant mortality rate from death records corrected data with EFS and EDHS surveys, values are quite similar for to the most recent years. For older years surveys values do not follow perfectly those of the death records corrected: the rate estimated by the surveys are indeed lower than those of vital records. For the years 1950, 1960 and 1970, the data used are those of the EFS Survey 1980. During survey mothers interviewed tend to forget the deaths of children who occurred long before the date of completion of the questionnaire. It seems the more likely cause of this discrepancy and we suggest that the data from EFS underestimate the infant mortality rate for the period.

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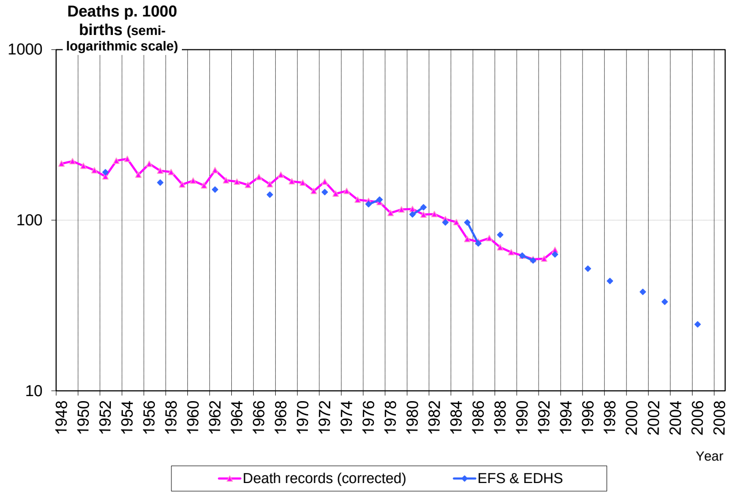
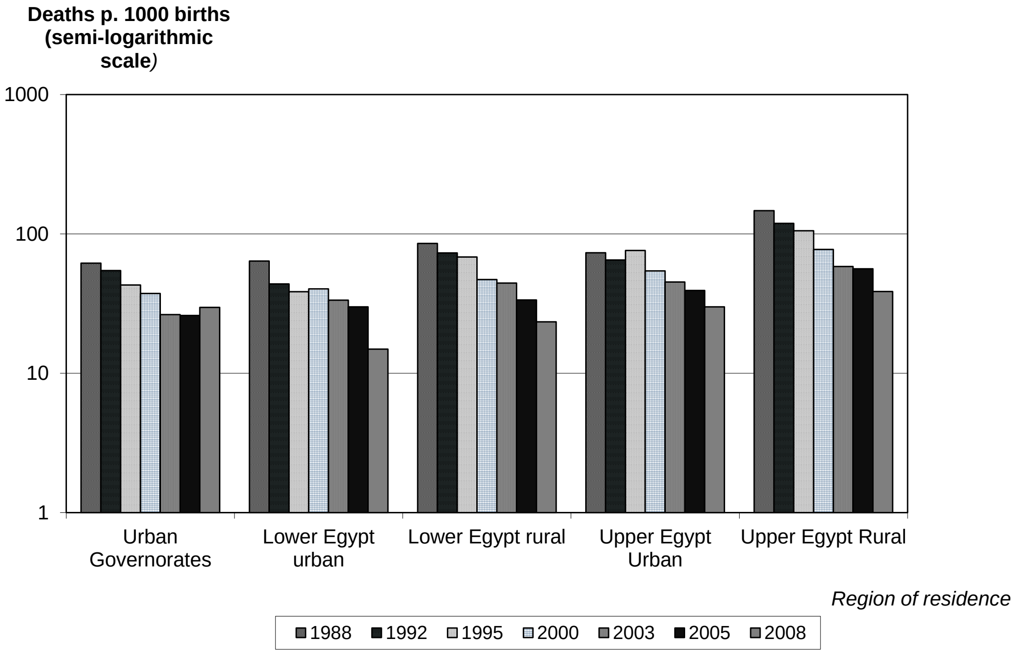
Figure 1.- Evolution of infant mortality rate in Egypt 1948-2007



Sources: Death records: 1948-1970 corrected by Fergany (1975), 1971-1992 corrected by Fargues (2002), 1993-2007 corrected by Ambrosetti (2011). EFS 1980 and EDHS 1988-2008.

Since the 1950s, there has been a drop in infant mortality, however rates were still high for a long period; only since 1980 it fell below 100 ‰; between 1970 and 1986, the infant mortality rate has dropped by about 50% (148 ‰ in 1971 to 74 ‰ in 1986). During the 1980s and 1990s, infant mortality recorded significant progress. In 2001, the number of deaths per 1000 births was 38 against 97 in 1984. Such an improvement of the health of children in their first year of life is to assign largely to the efforts of the Egyptian government in terms vaccination policies (Ambrosetti, 2011)

Figure 2.- Infant mortality rate by region of residence, Egypt, 1988-2008



Sources: EDHS, 1988-2008.

However differences are still significant between governorates (Figure 2): in urban governorates, the 2008 level is 29 deaths per 1,000 births. In rural Upper Egypt, mortality remains very high: about 39 ‰. In Figure 2, we also note that children's health is generally better in the city than in the countryside. In the Egyptian context, delayed fertility transition compared to neighboring countries, can be in part ascribed to the delay in the fall of infant and child mortality rates. Previous studies on small area estimation of fertility (Bonneuil and Dassouki, 2006) has showed the importance to analyze geographical differentials in fertility and its determinants. However, no previous studies had attempted to estimate infant and child mortality in Egypt for small geographical areas. In this country, there are thousands of small geographical units. In addition, strong socio-economics differences and inequalities exist between urban and rural setting, Upper and Lower Egypt and even between small area in the same region or city. Those differences justify the need to calculate infant and child mortality rates at the local level. Small area models are particularly important for less developed countries population estimate, in order to address health policies and resources to regions where spatial inequalities are strongly marked.

Research aim and methods

The problem described in the previous section can be formalized as an estimation problem in small domains. This issue has been receiving a lot of attention in statistical literature (see Rao (2003) for a review). The model-based approach is widely used to tackle the small area estimation problem. The model in Fay and Harriot (1979) is the most popular small area model when data are available at area level: it borrows strength from all data available from all areas by assuming a hierarchical structure and uses auxiliary information from other data sources that might be available from administrative records or censuses. The Fay-Herriot model is linear mixed model with random area effect and the usual random error. The variances of the error term are known. The Fay-Harriot estimator results in a convex combination of the direct estimate and the predicted value from the model. Properties of the small area estimators, such as bias and mean squared error, are derived conditionally on the auxiliary information and under the assumption that auxiliary data are measured without error. Following Fay and Harriot (1979), we consider a very common situation in which auxiliary data are available for all areas although auxiliary data are measured with error.

Suppose there are m small areas of interest and let Y_i denote the population characteristic of interest in area i. Let y_i be a direct estimator of Y_i for area i and let $\hat{x}_i$ be an estimator of the p-vector X_i of auxiliary data. We also assume that $MSE(\hat{x}_i)=C_i$ under the sampling design. A simple estimator accounting for the measurement error can be obtained as in Fay and Harriot (1979) but with $\hat{x}_i$ instead of the true value X_i . However, Ybarra and Lohr (2008) show that, under general conditions, this simple estimator may be even worse than the direct estimator. Moreover, ignoring the fact that X_i is measured with error underestimates the mean squared error and will give a misleading notion of precision.

Following Arima et al. (2012), we will consider a Bayesian hierarchical model . The model in Fay-Harriot (1979) is a linear mixed effect model which can be easily written, in a Bayesian framework, as a multi-stage model. The first stage is represented by the likelihood of the model; in the second stage we specify our prior belief with respect to the unknown parameters. In order to reflect our prior ignorance, we use improper uniform prior distributions for all unknown parameters. The posterior distribution is then proportional to the product of the likelihood and the prior distributions, and, as shown in Arima et al. (2012), it is proper. Variability of the small area mean estimators will be evaluated through the variances of the posterior distributions. Small area statistics are particularly important for less developed countries population estimate, in order to address health policies and resources to regions where spatial inequalities are strongly marked. In the

Egyptian context, delayed fertility transition compared to neighboring countries, can be in part ascribed to the delay in the fall of infant and child mortality rates.

Data

We will compare the proposed models using data coming from Egyptian Demographic and Health Surveys (EDHS) of 1995 and 2005, Egyptian population register (Death registration) and Egyptian Population and Housing Census (1996 and 2006). To analyze the evolution over time of child and infant mortality, we will use the data of death records and EFS and EDHS surveys, the latter will be the source for calculating mortality below 5 years.

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