Nota

Approximating the educational differences in mortality: demographic indirect techniques

Aproximando as diferenças educacionais em mortalidade: aplicação de métodos indiretos

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ABSTRACT
There is evidence that education is important in survivorship, especially among children. As the survivorship at advanced ages is a cumulative experience through life course, education is a factor that influences survivorship, since it is achieved over time. Available mortality data are inappropriate in Brazil, according to social and economic levels and education. There is still a high proportion of non-declared information about education in administrative databases. Therefore, indirect techniques, widely used in demographic research, were applied in order to estimate survivorship functions by ages, using National Research for Sample of Domiciles (PNAD, acronym in Portuguese) data. Brass Method was used for child mortality and the method of orphanhood for adult mortality. Then, the estimates were unified in order to generate complete survivorship functions.

Keywords: Brass method; mortality; demography; education.

RESUMO
Há evidência de que a educação é importante no que tange à sobrevivência, especialmente entre as crianças. A sobrevivência em idades avançadas é uma experiência acumulada ao longo dos anos de vida e, por isso, a educação é um fator que influencia a sobrevivência, pois também é adquirida com o passar dos anos. Contudo, sabe-se que os dados de sobrevivência são inadequados no Brasil, segundo estrato socioeconômico e educação. Há, ainda, a elevada proporção de informação não declarada sobre educação em bases de dados administrativas. Assim, técnicas indiretas, amplamente utilizadas em demografia, foram aplicadas neste trabalho para se obter a função de sobrevivência por idades, usando dados amostrais da Pesquisa Nacional por Amostra de Domicílios (PNAD). Os métodos utilizados foram o Método de Brass para a mortalidade na infância e o método de orfandade para os adultos. Em seguida, as estimativas foram unificadas para gerar funções completas de sobrevivência.

Palavras-chave: método Brass; mortalidade; demografia; educação.

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DESCRIBING THE INDIRECT DEMOGRAPHIC TECHNIQUES

The importance of education in survivorship is well documented, especially among children[1-3]. As the survivorship at advanced ages is a cumulative experience through life course, differences in education are influent in survival at older ages. In Brazil, available mortality data are inappropriate when stratified by educational level, given the high percentage of missing information on education[4]. This way, indirect demographic techniques were applied in order to estimate survivorship functions by educational attainment using the National Research for Sample of Domiciles (PNAD, acronym in Portuguese) data.

First, it is important to understand that demographic indirect techniques or demographic estimation methods are based on census or surveys alone and are used when registration systems are of poor quality or do not exist[5]. For the purpose to estimate a complete mortality function stratified by education, two indirect techniques were combined: (1) the Brass Method for child mortality estimation, using information on children ever born and children surviving, and (2) estimation of survivorship to adulthood from birth, applying maternal orphanhood data. The latter technique produces conditional survivorship estimates. In order to obtain the unconditional adult survivorship probability and complete the mortality function for all age groups, the linkage method[6] was applied. This method uses an estimate of child mortality, obtained from the first method, which is linked to a model life table that, on its turn, is combined to adult survivorship probabilities in order to obtain unconditional survivorship probabilities used to construct a whole life table.

THE BRASS METHOD FOR CHILD MORTALITY

The child mortality indirect method estimates child mortality from census questions to the mother about children ever born and surviving children. The basic idea of the method is to transform the proportion of dead children into life-table measures. The method estimates probabilities of dying by age x to x+n (nqx) converting the proportions of dead children (ndx) in relation to ever born children to women over her reproductive ages. For example, suppose all women had children at age 25, and they were asked about the survivorship of their ever-born children at age x. This would give an approximation of the life-table measure of children aged x-25.

Formally, the probability function is estimated as nqx=ndx*nkx.

The probabilities of survivorship are obtained through the application of multipliers (nkx) that aim to adjust for the fertility history of a group of women[5]. In spite of being more flexible and updated, the regression method using Trussell's coefficients[6] was not the best choice for the study by Guedes et al.[7] because they are based in Coale-Demeny standards, which are not the most adequate models for the Brazilian mortality pattern. For this reason, the original Brass multipliers[8] were applied. They have the advantage of being independent of a mortality pattern, using just parameters of the fertility pattern for interpolation.

The PNAD database is statistically representative for Brazil. Nevertheless, when data are stratified, as required for the Brass Method for child mortality estimation, the proportion of children surviving by age and education of mother is unstable. In order to smooth the distributions – across mother's age – of the proportion of children dead by sex of child and by the educational attainment of mother, the total population distributions of these proportions by sex of children and by educational level were used.

Once educational differences by age group were obtained, for both sexes, as well as the proportions of children dead by sex (for both educational groups), Guedes et al.[7] assume that the sex gap in proportions of dead children remained the same for both groups of mother's educational attainment. This is not implausible, since there is no reason to believe the mother's education makes her selective in maximizing the survivorship of children according to their sex. Keeping the same sex gap in mortality, the distance to the central proportions of children dead to the extremes corresponding to the proportions by educational level in each sex was applied. With this strategy, the sex proportions of children dead were preserved and, as a consequence, the educational difference was introduced.

THE METHOD OF ORPHANHOOD FOR ADULT MORTALITY AND THE LINKAGE METHOD

The orphanhood method estimates adult mortality from survey and census data on the survivorship of parents, normally of the mother. The question about the survivorship of parents provides estimates of the proportion of children in various age groups with parents alive at the time of the survey. For example, to estimate female adult mortality it is used the proportion of individuals who have living mothers. The age of the individual is an approximation of the period of the risk of dying that mothers have been exposed. The mean age of mothers is taken from the fertility age profile and it is determined by the average age in which women had children over a pre-determined period of time, normally 12 months prior to the survey[9,10]. Then, assuming that mortality of mothers and children are independent, and that the age of the mothers at the birth is X, the proportion of mothers alive of children aged Y is a measure of survivorship of mothers between the ages X and Y.

The method used to estimate adult unconditional survivorship depends on the assumption that the models used in simulating data adequately represent the true underlying survivorship function of the population under analysis, for it is based on equations fitted by least-squares regressions to simulated data[6]. As explained, the second strategy of estimation uses, as input, an average estimated value of l(2) – the probability of surviving at age two. Therefore, an additional assumption required, which the model life tables used to produce the simulated data, from childhood to adulthood, cover the range of actual experience. Because of schedule instability, even after the use of a smoothing technique, l(2), l(3) and l(5) – which are the probability of surviving at exact ages two, three and five in a life table – were averaged as a proxy for child mortality experience.

To obtain the male adult mortality, the estimated female survivorship function was used and compared with an implicit female Coale-Demeny model life table. Then, the corresponding male Coale-Demeny model life table was used and the same age differences in the estimates between the two female functions (the model and the estimated) were applied. Using this strategy, an additional assumption was introduced, in which the sex difference in the Brazilian mortality function was identical to the sex difference of survivorship embodied in the model life tables.

A strong argument, valid for Brazilian mortality, is that there is a significant sex differential in mortality, especially due to difference in exposure to risk of death by violent cause and other external reasons. On the other hand, it is not clear if this sex differential, relatively true for the child mortality, can be replicated for adult mortality. Therefore, the sex differences implied in the model life tables were preserved.

THE LINKAGE METHOD

The Brazilian mortality pattern is relatively unique in having a strong mortality difference by sex, especially among young people. Young men are more frequently engaged in risky behaviors and, in Brazil, the violence and road accidents impact more men than women, especially among the lowest socioeconomic strata, causing a hump in the male mortality function by age between ages 15 and 30. The Coale-Demeny families of model life tables are not the most appropriate standards to be applied to the Brazilian pattern for the lower educated group. The closest approximation of Brazilian mortality pattern is the Chilean pattern, from United Nations[6]. The proximity of the Chilean mortality pattern can mostly be explained by the very high inequality in the income distribution of the Chilean population[11].

If a sample was stratified in two groups by the mother's educational level (and respondent, for adult mortality), the higher educated group generated estimates, out of Chilean Model Life Tables range, in the case of women mortality. Even using a second degree polynomial by age across different life expectancy at birth – within a range varying from $61 \leq e_0^o \leq 75$, covering 15 levels and applying the constraint imposed by the mortality curve (non-negative values), using the logit transformation for each l(a) and, then, generating the observed $\lambda(a)$ – the final estimates of two logit parameters were very far from the original forecasted standard values. For this reason, alternative model life tables were considered and the North model from Coale and Demeny[12] were finally elicited. With this change in mortality standard, it was implicitly assumed the same difference in mortality pattern between the two educational groups.

To link the estimate of child mortality to the adult conditional mortality, it was applied the iterative method described in the United Nations[6] in order to obtain an estimate of $l_f(25)$, that is, the probability of a woman to survive at age 25. This adult survivorship probability was used to transform the conditional expectations into unconditional adult survivorship probabilities. The consistency of estimates of adult mortality is sensitive not only to the relationship between child and adult mortality but also to the pattern of the mortality schedule between early child ages and 25 as well. Performing the comparison of a logit transformation of some l(a) points from a model life table and child and adult reasonable points, estimates for the survival functions for female was completed. As the PNAD questionnaire does not have a question about survivor status of fathers, just female adult mortality can be indirectly estimated. Once found the implicit mortality level in the estimated female survivorship, it was applied to the corresponding level for males in the model life tables, using linear interpolation.

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