The contribution of causes of death to the educational differentials in mortality in Brazil

Background

In previous decades, Latin American countries have experienced significant reductions in overall adult mortality. However, little is known about the distribution of these gains among population subgroups mainly due to poor data quality or even the lack of data. The studies already developed for countries with better data quality lead us to believe that, when dealing with socioeconomics subgroups, individuals in higher positions in the social hierarchy tend to live longer and healthier lives (Preston, Taubman, 1994; Rostron et al., 2010). In this paper, we use educational attainment as a measure of the individual's socioeconomic status (SES) to capture their family and community conditions, as well as their behavioral and social access associated gains. (Elo, Preston, 1996; Elo; Drevenstedt, 2002).

We base our work on the rationale that with the elimination or mitigation of infectious parasitic diseases, health improvements tend to be more related to socioeconomic developments, behavioral and cultural changes. (Meslé, Vallin, 2011). Along with the heterogeneity among Latin American countries, there is an overlapping of the epidemiological transition phases associated with differences within social, economic, and cultural systems (Queiroz et al, 2013) Hence, these overlapping phases, could also be observed among different socioeconomic groups in the same society creating a selectivity effect.

Even though the debate on educational differentials in mortality is already well established in developed countries, in most developing countries this debate is scarce. We consider Brazil to be a good representative of this group as its data is affected by persistent errors in age reporting as well as in the reporting of the deceased's information on educational attainment. (Grushka; Preston, 1996). When we look at adult mortality, we observe larger gains in general life expectancy, but the education differentials are more difficult to examine given the present socioeconomic inequalities in Brazil. (Gomes et al., 2013)

In this paper, we make an effort to add to what is already known about educational differences in adult mortality in Brazil by bringing the perspective of the causes of death. Ignoring these causes may have a similar effect as disregarding the effect of exposure or contraceptive efficacy when studying fertility, as they represent biological variables through which all social and environmental influences must necessarily operate. (Preston, 1976)

Methodology

The methodological challenge this paper attempts to tackle is how to complete education attainment data making the imputation as robust as possible given the initial characteristics of the data. To do that we used the information on mortality and the deceased education attainment available provided by the Brazilian Ministry of Health (SIM[1]), and selected 16 Brazilian state capitals given that they have shown less than 20% of education missing data to preserve the original structure of the data set. Thus, 'Brazil' in this study refers to all 16 capitals mentioned. The estimations were made for the 45 to 80 years in five-year age groups. The lower limit of the age groups by that all individuals would have finished all possible transitions defines being an adult (marriage, first child, employment, and end of school/university life).

We have selected the groups of causes that together comprised more than 70% of the total deaths among adults. The selected causes, with their respective ICD-10 chapters: Infectious parasitic diseases (Chapter I), Neoplasms (Chapter II), Diseases of the circulatory system (Chapter IX), Diseases of the

[1] Available for free access and download at: http://www2.datasus.gov.br/DATASUS/index.php?area=0205 (in Portuguese)

respiratory system (Chapter X), External causes (Chapter XX), Ill-defined causes of death (Chapter XVIII), and other causes.

The hot deck method fills in the missing values by using an observed response of a similar unit to generate a complete data set. The donor strata are defined as being: the location where the person died, their age, and sex. It is important to point out the restrictive character of these parameters; however, this selection was made given their quality and completeness in the mortality database. If other variables were taken into account, the strata would be smaller and with that, the efficiency of the method would be compromised. To make the imputation more robust, we considered only three education attainment categories: less than 7 years of study (incomplete primary school); 8 to 11 years of study (complete primary school and incomplete high school); and 12 or more years of study (complete high school).

Then, we used the decomposition method proposed by Firebaugh et al (2014), which estimates the contribution of each cause to the longevity gap between two groups of characteristics α and β. We can differentiate whether the individuals with α characteristics are more likely to die from the cause c than those with β characteristics, or if the former die, on average, younger. The measure of the difference in longevity is related to two components: the variation in mean age at death by cause *c*; and the incidence of cause *c*, where $\bar{q}_c$ is the average probability of dying for cause *c*.

The method estimates two different components. The age component is estimated so that the difference between the mean age at death by cause *c* and the two groups are weighted by the average probability of dying for cause *c*.

$$age\ component = \bar{q}_c\left(\bar{x}_{c\alpha} - \bar{x}_{c\beta}\right)$$

The incidence component determines that the variation in the probability of dying affects longevity more significantly for those causes that are more frequent at the end of the age-to-death distribution.

$$incidence\ component = (\bar{x}_c - \bar{e}) * \left(q_{c\alpha} - q_{c\beta}\right)$$

Initial Results

Our results show the existence of a persistent differential by cause, suggesting that the effects associated with the socioeconomic inequalities last through the life cycle of the individual. Therefore, it affects the probabilities of dying for different causes, which are then associated with education.

Negative values for both components indicate that those with fewer years of formal education suffer losses in longevity, while positive values indicate losses for those with more years of formal education. As the adopted decomposition method only allows the comparison of two characteristics (α and β), and we use three education categories, two-by-two comparisons were made for each cause of death group.

When we compare with the incidence component (Table 1), the greater contribution of the age component to the differential suggests that those with lower schooling, on average, die younger than those with higher. Compared with the incidence component, the greater contribution of the age component to the differential suggests that those with lower education die, on average, younger than those that spent more years in formal education.

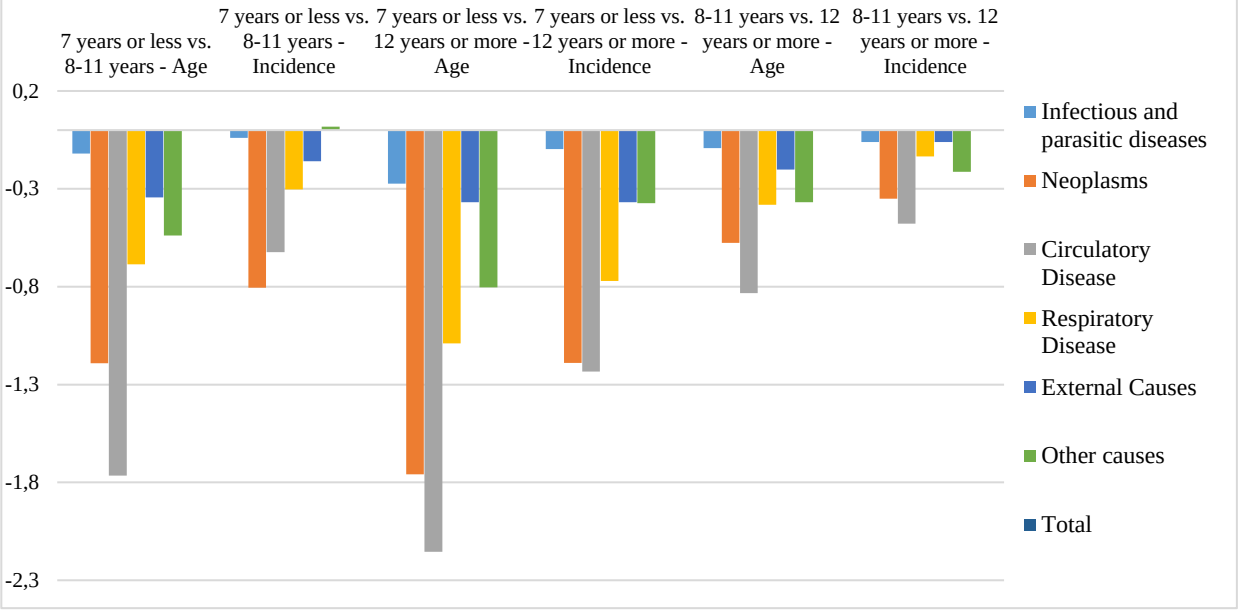
Table 1: Age and Incidence total effect for all causes of death when comparing each education attainment group in pairs - Brazil - Both Sexes

	7 years or less vs. 8-11 years		7 years or less vs. 12 years or more		8-11 years vs. 12 years or more	
Components	Age	Incidence	Age	Incidence	Age	Incidence
Total Effect	-4,65	-2,06	-6,48	-4,04	-2,47	-1,18

Both the incidence and the age effects are more intense for neoplasms and cardiovascular diseases, resembling the results found by Rogers et al (2016) for the United States (Graph 1). There is a smaller

difference between longevity losses when we compare the results of the comparisons between those that did not complete primary school with those who have (7 years or less vs. 8-11 years) and those who have only completed primary school to those who have completed secondary school (7 years or less vs. 12 years or more). This behavior suggests that the most significant gains are achieved by transitioning when completing primary school. The selected causes of death for all decomposition exercises have shown a significant effect on the differential in life expectancy. The sum of all effects for each cause group can explain on average 85.4% of the total differential for life expectancy.

Graph 1: Age and incidence components and their individual contributions to the difference in life expectancy when comparing between years of education for those 45 years and more – Both Sexes - Brazil

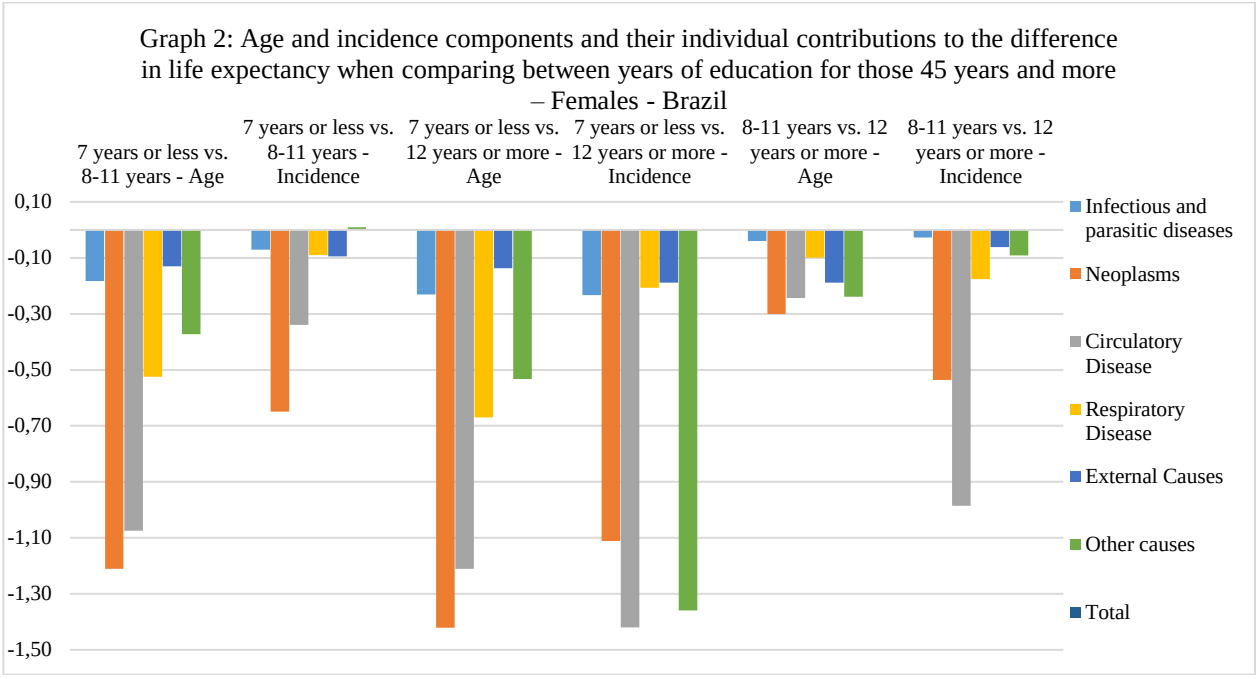


When decomposing by educational subgroups for both men and women we also found a consistent differential (Table 2); however, the effect seems more intense for women for neoplasms whereas for men this effect is greater for circulatory diseases.

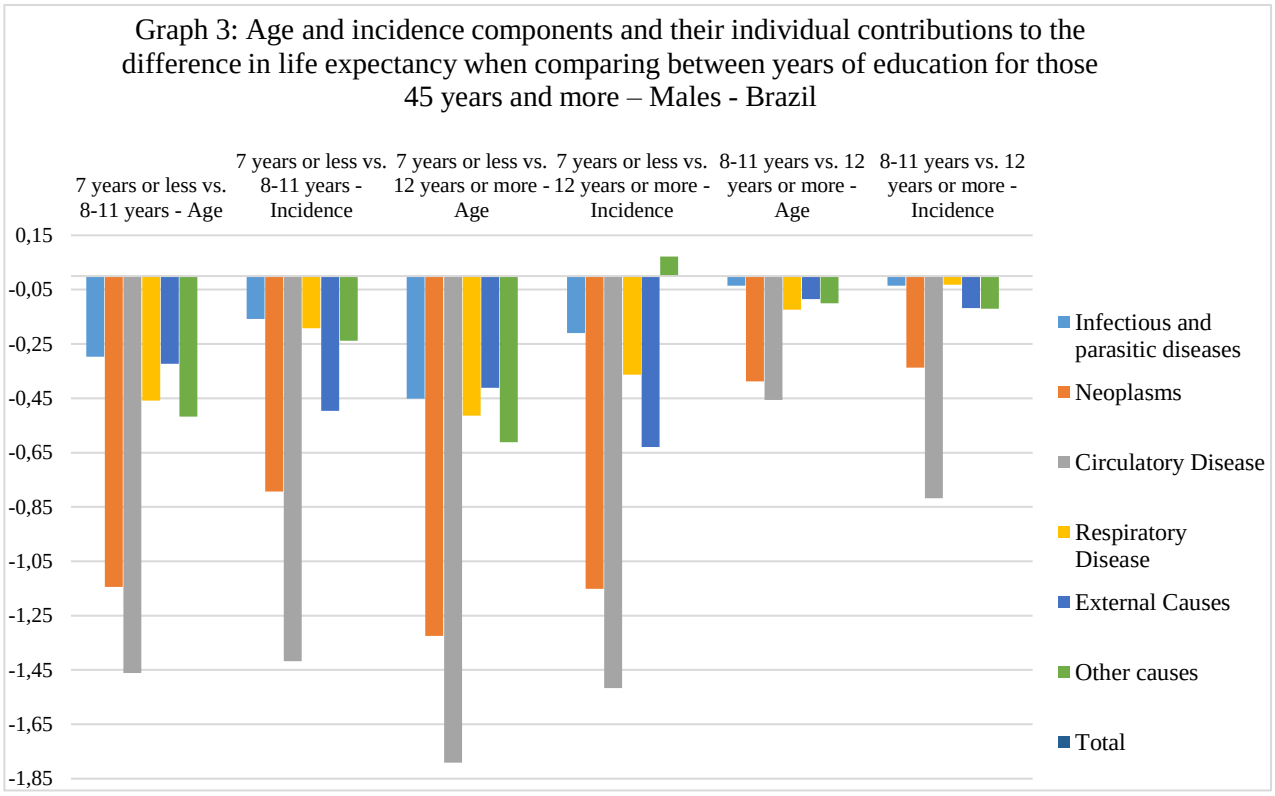
Table 2: Age and Incidence total effect for all causes of death when comparing each education attainment group in pairs by sex- Brazil

	7 years or less vs. 8-11 years		7 years or less vs. 12 years or more		8-11 years vs. 12 years or more	
Components	Age	Incidence	Age	Incidence	Age	Incidence
Females	-3,50	-1,45	-4,20	-3,56	-1,11	-1,60
Males	-4,20	-3,66	-5,10	-4,63	-1,19	-1,07

In the female case (as seen in graph 2), mainly for neoplasms and diseases of the circulatory and respiratory systems. The coefficients of age and incidence between the groups with 8 to 11 years of study (complete primary school) and 12 years and over (complete secondary school) are smaller when compared with the differences estimated for those with 7 years or less (incomplete primary school) and those who completed primary school. The negative coefficients indicate that all the selected causes contribute to the life expectancy differential. That means that women with fewer years of schooling, on average, negative incidence components indicate that women 45 years old and older with higher education tend to be less likely to die from neoplasms, compared to those with lower education.



We observe this same behavior in men's case (shown in graph 3), but less intense when compared to the women's case. Thus, the life expectancy gains produced by transitioning between completing primary school and completing secondary school are smaller. In addition, men's results show absolute effects that are more significant for diseases of the circulatory system concerning the other groups of causes. However, the negative effects of incidence and age observed for all causes indicate losses in longevity for the less educated men. With this, the effect of education on the differential in life expectancy is smaller between men when we compare to gains among women.



Conclusion

In all cases, more significant absolute effects were found for neoplasms and circulatory system diseases; in contrast, parasitic infectious diseases and external causes have the least significant components. Thus, this suggests that there is an overlap of two phases of the epidemiological transition, in the case of

neoplasms and cardiovascular diseases. There is also a selectivity effect, in which fewer years of formal education individuals have higher mortality from these causes when compared to those with more years of education. The decomposition results between education groups for males and females suggest that there is also an educational differential deeply related to these causes of death. For women, the most intense effect was associated with neoplasms while for men these effects are greater for circulatory diseases.

Despite this paper's limitations, we emphasize the importance of understanding how the socioeconomic gradient in mortality operates in the Brazilian scenario of demographic transition that is associated with persistent social inequality. Population aging at an accelerated pace, compared to that experienced in developed countries, has important consequences for societies given the economic and institutional fragility. Brazil is one of many different countries with several different levels of development, however, understanding better how these mechanisms operate in Brazil may aid in the study of similar processes.

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