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Descriptive Finding

Assessing the quality of education reporting in Brazilian censuses

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Marília R. Nepomuceno¹

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Abstract

BACKGROUND

In developing countries, improving access to schooling has been and remains a priority. At the same time, a growing body of research relates education to demographic variables. It is therefore essential to measure the educational variable accurately. In Brazil, although the high degree of inaccuracy in age reporting is known, previous research has neglected that problems of misreporting may affect other variables such as education.

OBJECTIVE

To fill this gap, we calculate mortality levels by education as implied by intercensal survivorship ratios to investigate the quality of self-reported education among adults in Brazil between the 1991 and 2000 censuses.

RESULTS

Our findings show evidence of inaccurate educational data in the censuses. Analysis by single year of schooling weakly reflects the known educational gradient in mortality. After categorization of age and years of schooling into groups, a positive relationship between education and survival does appear, although some implausible patterns remain.

CONTRIBUTION

This study is an important step in demonstrating and assessing potential errors in census education data in Brazil. We highlight the importance of efforts to improve the quality of data on education, particularly in countries where an educational expansion is underway and where deficiencies in data quality are a potential issue of concern.

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1. Introduction

Education is one of the keys to development and economic growth and is connected to demographic variables in many different ways. In virtually all societies, individuals with higher levels of education enjoy better health and longer lives (Preston and Taubman 1994; Elo and Preston 1996; Mackenbach et al. 1999; Koch et al. 2007; Zhu and Xie 2007; Rosero-Bixby and Dow 2009; Turra, Renteria, and Guimarães 2016; Lutz and Kebede 2018; Smith-Greenaway and Yeatman 2019). Highly educated couples have fewer children, mainly because they marry later, use contraception more effectively, and have more autonomy in reproductive decision-making (Singh and Casterline 1985; Potter et al. 2010; Bongaarts, Mensch, and Blanc 2017; Rios-Neto, Miranda-Ribeiro, and Miranda-Ribeiro 2018). Moreover, migration flows across regions with different developmental levels are usually associated with selection of migrants by educational group (de Haas 2010; Lewis 1986). It is thus not surprising that as educational enrollments expand worldwide, there is a growing emphasis on population forecasts by educational level (KC et al. 2010; Lutz and KC 2011; Lutz, Butz, and KC 2014).

As an essential variable in demographic analysis, accurate measurement of education is indispensable. Studies of the quality of reported education are not new in the literature (Folger and Nam 1964; Gustavus and Nam 1968; Black, Sanders, and Taylor 2003; Sorlie and Johnson 1996; Kane, Rouse, and Staiger 1999; Johnson-Greene et al. 1997; Battistin, Nadai, and Sianesi 2014; Lerch et al. 2017). Some of these have documented the misreporting of educational levels in data systems. For example, in both the 1950 and 1960 US census, there was a substantial amount of net overreporting, particularly at older ages for high school and college levels (Folger and Nam 1964). Examination of the 1990 US census detected misreporting of some doctoral and professional degree categories (Black, Sanders, and Taylor 2003).

One of the consequences of education misreporting in census data is the miscalculation of the denominator of demographic rates, which can bias the measurement of educational gradients. In mortality analysis, for example, where death rates usually derive from two independent data sources – vital statistics (death counts) and census data (exposures-at-risk) – disagreement between reported education in the numerator and denominator may affect conclusions about how mortality differentials by education vary across age, gender, race, and geographical groups. Several authors have documented disagreements between death counts and population census records by education in Europe and the United States. The level of disagreement tends to increase with age in Lithuania (Shkolnikov et al. 2007) and for some racial/ethnic groups in the United States, such as blacks and Hispanics (Rostron, Boies, and Arias 2010). However, even among population groups that are less likely to report educational levels differently across data sources, changes in the census questions can lead to inconsistent information over time (Lerch et al. 2017).

In Brazil, research has neglected the possible effects of education misreporting in demographic, social, and economic studies. Although several authors have looked at coverage errors, both in vital and census data (Paes and Albuquerque 1999; Paes 2007; Lima and Queiroz 2014; Cavenaghi and Alves 2016), demographers have paid less attention to content errors, and analysis has mostly been limited to age misreporting (e.g., Paes and Albuquerque 1999; Agostinho 2009; Gomes and Turra 2009; Turra 2012; di Lego, Turra, and Cesar 2017; Nepomuceno and Turra 2019). Some of the processes underlying the measurement of age may be the same for other household and individual characteristics, including education, income, fertility, and mortality. The list of common problems comprises recall bias, the inability to provide correct information, the lack of certificates and other essential family documents, errors made in imputing values for missing data, and selective coverage errors.

This article examines the quality of information on education in Brazilian census data. We calculate mortality levels by education as implied by intercensal survivorship ratios to investigate the quality of self-reported education data among adults in Brazil between the 1991 and 2000 censuses. Here, we hypothesize that education reporting errors are more substantial during times of accelerated expansion of schooling, such as the period that characterized the education system in Brazil after 1980, amplifying the types of errors that are common to other census variables. In the 1950s, half of the Brazilian population was illiterate, and only 36% of individuals in the age group 5–14 were enrolled in school. Since the late 1980s, the overall picture has changed: illiteracy rates have reduced sharply to less than 15%, and nearly all children younger than 15 were attending school in 2000 (Rios-Neto et al. 2010). Also, the enrollment rate for secondary education has risen fast, from 30% in 1980 to 80% in 2010, and more than three million individuals have enrolled in tertiary education during the 2000s (INEP 2001, 2011).

The rapid educational transition may have influenced the reliability of education data in at least three different ways. First, if better-educated individuals tend to report their characteristics more accurately, mainly when information is retrospective, errors will be more substantial in earlier data collections and among older cohorts. Second, the expansion of education may have changed people's perception of their relative social position. Older age groups, who lived their schooling years before the development of the education system, may feel inclined to overstate their educational levels to level off any cohort differences. Finally, the expansion of schooling has been followed by changes in the education system and census questions, affecting the comparability of responses over time. Given the global effort to improve access to schooling (United Nations 2015a,b), our results aim to draw attention to the accuracy of reported education not only in Brazil but also in those countries where educational expansion is underway and where deficient data quality is a potential issue.

2. Data and methods

We drew data for men and women from the 1991 and 2000 Brazilian Census (IPUMS-I 2019). We restricted our analysis to ages 40 to 89, since formal education is unlikely to change for most Brazilian adults after age 40. According to census data, most individuals were not attending school at these ages: 99.5% and 97.3%, respectively, in 1991 and 2000.

Although the most recent census data available are from 2010, the exclusion from the questionnaire of information on the highest grade completed precluded us from using the data for that year. To have an exact 10-year interval between periods, we estimated the population by age and sex for the year 1990 based on the set of sex- and age-specific growth rates between 1991 and 2000 and the population in 1991. To avoid introducing additional bias to our estimates from projecting education backward, we kept the 1991 distribution of years of schooling by age and sex constant in 1990. Using the original 9-year interval between periods instead of the exact 10-year interval would generate virtually the same results and conclusions. Thus, we opted for the more conventional 10-year interval.

We measured educational attainment as the highest grade completed within the most advanced level attended in the education system. We used the IPUMS harmonized variable named YRSCHOOL, which accounts for the number of years of schooling.

To evaluate the quality of self-reported education, we assessed the implicit mortality by education between the two censuses through intercensal survivorship ratios (ISR) by age, sex, and educational attainment:

$$ISR_x^{k,i}(j) = \frac{N_{x+j}^{k,i}(t+j)}{N_x^{k,i}(t)}, \quad (1)$$

where $N_x^{k,i}(t)$ is the cohort at age x , sex k , at educational level i in the year t , and $N_{x+j}^{k,i}(t+j)$ is the same cohort j years older at the educational level i and sex k in the year $t+j$. In our first analysis, we used a single number for years of schooling, from 0 to 12 or more. Next, we calculated the number of years of schooling categorized into four intervals: 0–3, 4–8, 9–11, and 12 or more, which correspond respectively to the first and second stages of the primary, secondary, and tertiary education.

After the categorization of the years of schooling, values of the ISR at each age were translated into life expectancy at age 40 in the West model of the Coale–Demeny life tables (Coale, Demeny, and Vaughan 1983). We used the United Nations version of the tables, which extends the original mortality levels to include life expectancy at birth up to 100 years (United Nations 2017). This allowed us to assess the consistency of the adult level of mortality across age and educational groups.

The ISR capture changes in the cohort size during the intercensal period. In the

absence of international migration and changes in census data quality, one should expect survivorship ratios to be less than one due to the impact of mortality. It is reasonable to assume that the Brazilian population was closed to migration at ages above 40 between 1990 and 2000. According to earlier studies, international net migration rates were shallow during the 1990s, reaching less than 0.5% for the population aged 10 years and older (Carvalho and Campos 2006; Campos 2011), and even lower values at older ages (Garcia 2013). Yet, we did measure the effect of migration rates (Carvalho and Campos 2006) on the ISR. The sensitivity analysis by age and sex (rates by education are not available), shown in the appendix, confirmed the effects to be negligible.

To mitigate the effect of changes in census coverage on the ISR, we also adjusted the census enumeration according to the mean omission rates for all ages by sex (1.04 and 1.03, respectively, for males and females for 1990, and 1.03 for males and 1.02 for females in 2000) (Tacla-Chamy 2006; IBGE 2008). Omission rates are not available by education, but we understand they can still help mitigate any differences in census enumeration between 1991 and 2000.

We expect survivorship ratios to increase with educational attainment. Earlier analyses that used surveys or data from the Mortality Information System of the Ministry of Health suggested a strong educational gradient in adult mortality in Brazil (Rentería and Turra 2009; Turra, Rentería, and Guimarães 2016; Turra, Ribeiro, and de Xavier Pinto 2018). Despite the existence of public programs to improve or supplement adult education, we expect only negligible gains in education over time at ages above 40 in Brazil. Between the 1991 and 2000 censuses, the proportion of individuals who reported not attending school varied from 99.2% to 96.5% for the age group 40–49, and from 99.6% to 98.2% for the age group 50–59. For older age groups, these proportions were even higher and more similar in the two censuses: between 99.7% to 99% for the age group 60–69, 99.8% to 99.3% for the age group 70–79, and 99.8% and 99.4% for individuals aged 80 and older.

3. Results

Table 1 presents the distribution of education by age group and sex in Brazil. In both years, there is a substantial proportion of adults in the least educated groups and a smaller percentage in the most educated categories. Between 1990 and 2000, the most considerable change in the education distribution is among the least educated (zero to three years of schooling), mainly for younger age groups because of the advance of the education transition in the country. For older age groups, proportions varied only slightly over time. Table 1 also shows gradual changes in the distribution of education by sex. As younger cohorts reach mature ages, the sex difference shifts to favor women. For example, compared to men, there was a lower proportion of women 40–49 years old with 12 or more

years of schooling and a higher share with 0–3 years of schooling in 1990. The situation reversed in 2000.

Table 1: Distribution of education (%) by age: Brazil, women and men, 1990 and 2000

Age group	Years of schooling							
	0–3		4–8		9–11		12+	
	1990	2000	1990	2000	1990	2000	1990	2000
Women								
40–49	46.05	29.12	36.40	41.59	10.31	18.11	7.24	11.18
50–59	57.30	44.67	32.49	36.55	6.55	11.07	3.66	7.71
60–69	65.01	56.56	28.14	32.55	4.79	7.06	2.06	3.84
70–79	71.10	62.41	23.59	29.48	4.13	5.76	1.18	2.34
80–89	74.09	68.32	21.71	25.18	3.40	5.11	0.80	1.40
Men								
40–49	42.95	29.35	38.39	42.83	9.71	16.95	8.95	10.87
50–59	52.43	41.69	34.78	38.13	6.80	10.73	5.98	9.45
60–69	61.40	53.25	29.34	33.33	4.76	7.29	4.51	6.13
70–79	69.86	61.95	23.50	27.90	3.09	5.18	3.55	4.97
80–89	73.98	69.87	20.45	22.85	2.55	3.40	3.03	3.88

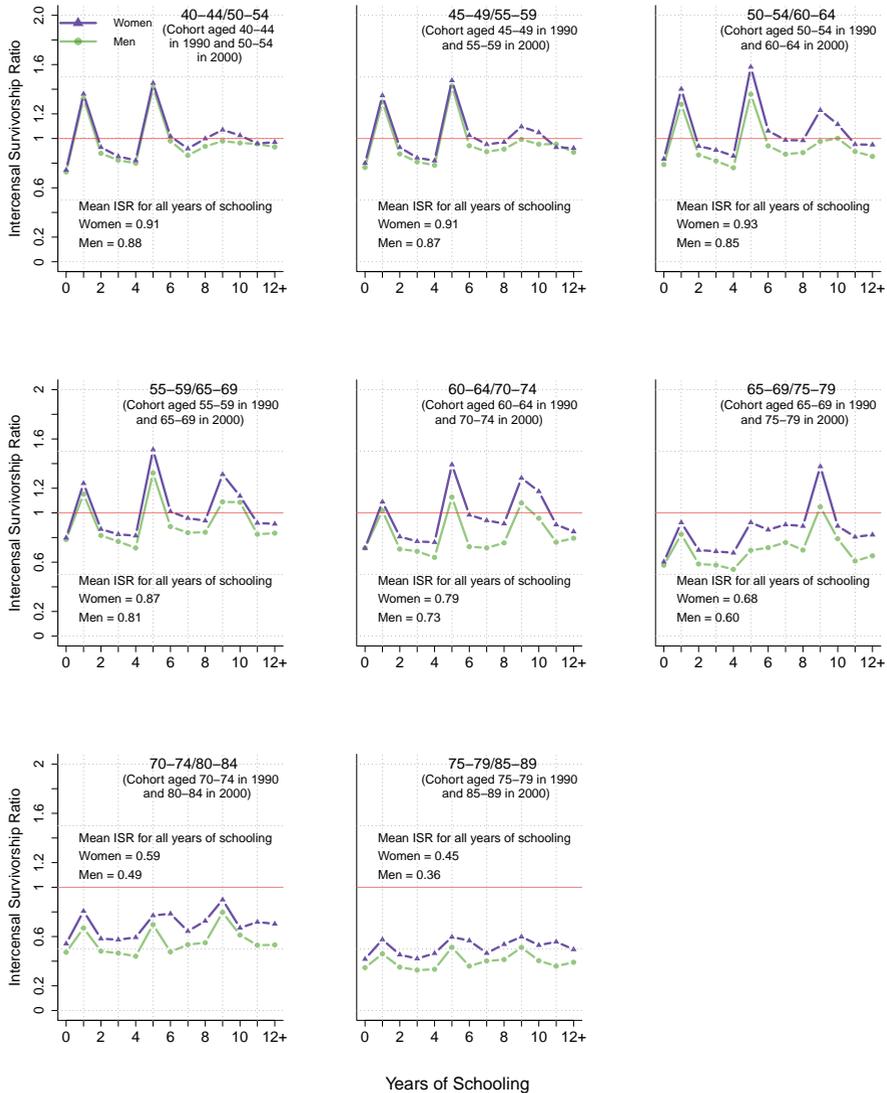
Source: Census data (IPUMS-I 2019).

Figure 1 presents intercensal survivorship ratios by age, sex, and a single number for years of schooling. The estimates show an irregular and unexpected pattern of the ISR by education. First, except for the oldest cohorts (70–74 and 75–79 years old in 1990), the ISR can get higher than one, suggesting that the size of cohorts increased between the censuses for some years of completed schooling, despite the impact of mortality. Second, the ISRs do not increase monotonically with education. Although survivorship tends to increase at higher years of schooling, it fluctuates over the distribution, varying sharply, particularly at one, five, and nine years of schooling. For example, the number of men and women aged 40–44 with one year of schooling increased by more than 30% between 1990 and 2000, and by more than 40% for those with five years of schooling. For nine years of schooling, the number of women and men aged 55–59 reporting this level increased by 30% and 10%, respectively, between 1990 and 2000. Not surprising, survival ratios are lower for men than women, although the patterns by age and education look similarly odd for both sexes.

Figure 1 also presents, for each cohort, the mean ISR for all years of schooling together. (Figure A-1 in the appendix plots the mean ratios by age and sex.) The mean ISR is always lower than one, regardless of age cohort and sex. Consistent with the expected pattern, survival ratios are lower for women and decrease with age for both

sexes. However, even ISRs calculated by age and sex only are not free of errors, since age misreporting may affect the rate of survival decline with age, as we examine later. In any case, the comparison of the mean ratios with ratios by years of schooling in Figure 1 confirms that education misreporting introduces distinct and substantial deviations from the expected pattern when interacting survival and years of schooling in the Brazilian census.

Figure 1: Intercensal survivorship ratio by age and years of schooling: Brazil, women and men, 1990–2000



Source: Census data (IPUMS-I 2019).

One way to reexamine education reporting is by categorizing years of schooling into intervals (0–3, 4–8, 9–11, and 12 or more). Table 2 and Figure 2 show the results of this analysis, including the life expectancy at age 40 (e_{40}) from the West model of the Coale–Demeny life tables implied by the ISR. To further improve our estimates, we also recategorized the 5-year age intervals into 10-year age intervals, hoping to minimize the possible effects of age misreporting in the census, particularly at older ages (Agostinho 2009; Nepomuceno and Turra 2019).

After the recategorization, the educational gradient in mortality — the positive relationship between education and survival — emerges. Life expectancy at age 40 is 0.44 to 7.84 years lower for individuals with 0–3 years of schooling than for those with 12 or more years of schooling, depending on the age cohort and sex.

Table 2: Intercensal survivorship ratio by educational groups and decennial age groups: Brazil, women and men, 1990–2000

Age in 1990	Age in 2000	Years of schooling								Total	
		0–3		4–8		9–11		12+		ISR	e_{40}^*
		ISR	e_{40}^*	ISR	e_{40}^*	ISR	e_{40}^*	ISR	e_{40}^*	ISR	e_{40}^*
Women											
40–49	50–59	0.8671	28.51	0.8974	30.76	0.9600	37.64	0.9523	36.34	0.9103	31.88
50–59	60–69	0.8798	35.51	0.8931	36.49	0.9607	44.30	0.9344	40.74	0.9027	37.20
60–69	70–79	0.7090	35.87	0.7739	38.74	0.8881	45.15	0.8388	41.95	0.7438	37.33
70–79	80–89	0.5082	40.20	0.5646	42.04	0.6545	44.94	0.6241	44.20	0.5316	40.75
Men											
40–49	50–59	0.8410	26.66	0.8603	27.94	0.9570	36.21	0.9145	31.64	0.8740	28.81
50–59	60–69	0.8398	33.52	0.7925	30.67	0.8867	36.79	0.8469	33.96	0.8322	33.06
60–69	70–79	0.6747	34.94	0.6358	33.17	0.7287	37.26	0.7381	37.56	0.6720	34.80
70–79	80–89	0.4350	37.46	0.4229	37.37	0.4785	38.46	0.4762	38.35	0.4371	37.64

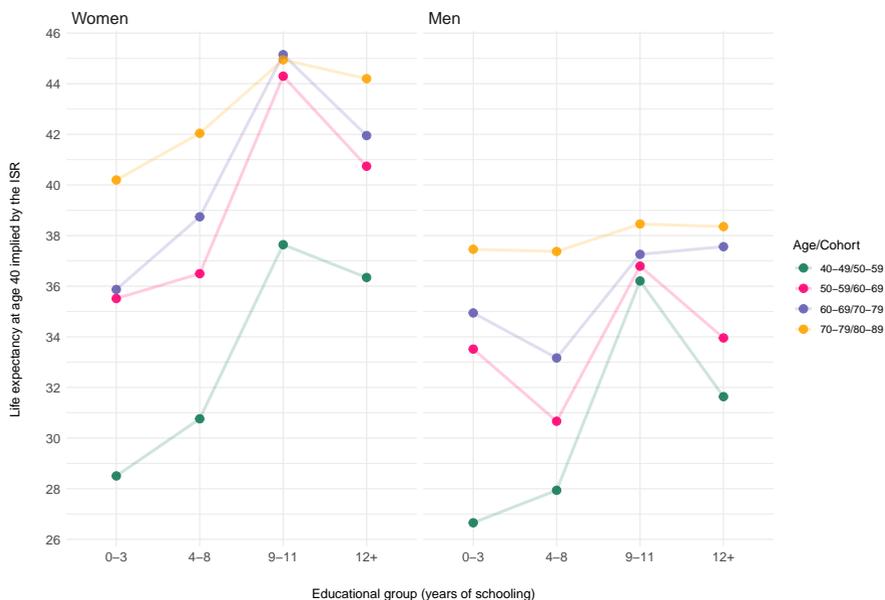
Note: * Life expectancy at age 40 calculated from the ISR and the West model of the Coale–Demeny life tables.
Source: Census data (IPUMS-I 2019) and United Nations (2017).

However, some implausible results remain after the categorization of years of schooling. First, Table 2 reveals that the survival advantage of the most educated groups does not decrease monotonically with age, which is inconsistent with findings from earlier literature (Elo and Preston 1996). For instance, the difference in e_{40} between the least and the most educated groups drops from 7.8 years for women aged 40–49 to 5.2 to those aged 50–59 in 1990. But it then increases to 6.1 years at the age group 60–69, reducing to 4.0 at 70–79 years in 1990.

Second, for most male and female cohorts, life expectancy reduces for individuals with 12 or more years of schooling compared with those with 9–11 years of schooling,

contradicting the expected educational gradient in mortality. This unusual pattern becomes clearer in Figure 2.

Figure 2: Life expectancy at age 40 calculated from the ISR and the West model of the Coale–Demeny life tables, by educational and age groups: Brazil, women and men, 1990–2000



Source: Census data (IPUMS-I 2019) and United Nations (2017).

Third, the survival levels implied by the ISR (e_{40}) vary substantially with age cohort, increasing at older ages. For the total population (ignoring education), the differences in e_{40} , between the youngest and the oldest age groups, are almost nine years for both men and women. The discrepancies are largest for the educational group 0–3 (10.8 years for men and 11.7 for women), reaching the lowest values in the group 9–11 years of schooling (2.25 years for men and 7.30 for women). Surprisingly, in the group with 12 or more years of education, the differences in e_{40} between the youngest and the oldest age groups increase again for both sexes. Age and education misreporting may be behind the observed patterns, as we discuss below.

4. Discussion and conclusion

Our study shows evidence of the inaccuracy of education reporting in the Brazilian censuses. The ISR by single number for years of schooling weakly reflects the known educational gradient in mortality described in the literature. After the categorization of the years of schooling, the positive relationship between education and survival is evident, although some implausible results remain.

An ISR higher than one, mainly at one, five, and nine years of education, suggests an unlikely increase in the cohort size between censuses. In the Brazilian education system, these grades correspond to the beginning of stages 1 and 2 of primary (1–4, 5–8 years of schooling) and the beginning of stages 1 and 2 of primary schooling (1–4 and 5–8 years) and the beginning of secondary schooling (9–11 years) in 1990. Therefore, the implausibly high ISRs at these points of the distribution suggest three possible (complementary) explanations. First, some adults may have genuinely moved between levels of educational attainment over the intercensal period, more than compensating the mortality effect. Second (and more likely), a fraction of the cohorts may have misclassified themselves as literate or as having some stage-2 primary or secondary education in the second census because of memory error to other self-reporting inconsistencies caused by changes in the social context, the census questionnaire, and educational reforms. Third, we may not have been able to control for the full effects of variations in census enumeration and flows of international migration in our estimates. However, we consider this to be a weak hypothesis given the type of systematic pattern of ISR by years of schooling we obtained in our analysis.

The cohorts we analyzed experienced at least two educational reforms after their schooling years that greatly changed the structure and the terminology of the education system, one in 1971 and another in 1996. For example, the first reform merged two levels that corresponded to grades 1–4 and grades 5–8 into a new level with grades 1–8 (Rigotti and Cerqueira 2004). Individuals who lived their schooling years before these reforms may have problems classifying themselves according to the new education system, re-

sulting in misclassification of their educational levels. Further, census questions designed to measure educational attainment changed over time, which may be another source of inconsistency. In the 1991 census, the questions used to calculate the highest grade completed within the most advanced level attended were “What was the last grade passed?” and “What was the last level passed”; while in 2000 the questions were “What was the highest course attended, in which you completed at least one grade?” and “What was the last grade passed?”. These changes point out some challenges in the comparison of the years of schooling over time, by age and cohorts, as revealed by our findings.

Educational gains may also contribute to the implausibly high ISRs. Since the number of individuals aged 40–49 with one year of schooling increased by more than 30% during the intercensal period, and part of this may be due to educational gains, we checked the proportion of illiterates who were attending school in the 1991 census and could potentially achieve one year of schooling between 1991 and 2000. This proportion was very low, reaching less than 0.05% in 1991 and less than 0.06% in the 2000 census. This small proportion is not enough to explain the striking increase in the population aged 40–49 with one year of schooling between the censuses.

To minimize the effects of age and education misreporting, we presented results by 10-year age groups and four intervals of years of schooling. After the recategorization, the educational gradient in mortality became more like the expected distribution and the estimated ISRs were all lower than one. The categorization of the years of schooling is an alternative design to reduce the effect of education misreporting. However, since there are substantial societal and economic differences among individuals within groups, by categorizing, we cannot measure important educational differences in mortality.

Despite our efforts to minimize potential errors, some inconsistencies continued, including lower life expectancy for individuals with 12 or more years of schooling than for those with 9–11 years of schooling. Since the quality of the reported information tends to be associated with the educational level of the informant (Budd and Guinnane 1991; Preston et al. 2003), a possible explanation for the unexpected decrease in e_{40} may be better data quality for individuals with tertiary education.

Another inconsistency was the substantial variation in mortality levels by age for the total population and at all educational groups. According to e_{40} implied by the ISR, levels of survival are considerably higher at older ages. One reason may be real differences between the age patterns of mortality by sex and education in Brazil and the West model of the Coale–Demeny life tables. Composition/selection effects by education and sex for different cohorts may also be relevant. However, the discrepancies in survival levels by age are too substantial to be due only to the choice of the standard model or cohort differences. Therefore, we offer two additional explanations involving associated content errors. First, age misreporting may play a key role since survival levels increase at older ages for the total population, regardless of education misreporting. Our findings are consistent with an earlier study that found that adult mortality increases with age at

a slower rate in Brazil than in countries with high-quality population and mortality data (Turra 2012). Second, education misreporting may interact with age misreporting as discrepancies in survival levels by age are different across educational groups. In this article, it was not our goal to disentangle the role played by each factor, an issue that deserves further analysis.

Overall, we found the same types of unusual patterns for both men and women. Also, consistent with the epidemiological context in Brazil, the estimated survival levels were higher among women than among men. However, some of the findings (such as higher life expectancy at 12 or more years of schooling than at 9–11 years of schooling) indicate that the discrepancies appear to be more substantial for women than for men. We propose three explanations for our results. First, the ability and readiness of men and women to answer the census questions may be different. Second, other types of census errors (coverage, age misreporting) can vary by sex. Finally, women had lower access to higher levels of education than men in the past. As a consequence, secondary and tertiary education has selected men and women of distinct socioeconomic and cultural backgrounds in each cohort, probably affecting mortality differentials by sex.

Since the estimates provided here show evidence of education misreporting in the census, our findings increase concerns about the true educational distribution of the adult population. Further, since the data on education attainment seem to be differentially misreported by age, sex, and educational level, the validity of age- and sex-specific demographic rates by educational level should be interpreted cautiously in Brazil. Furthermore, if education misreporting is different across censuses, trend analysis using these data will reflect erroneous patterns. Global studies that use census education data from developing countries to project population should be aware of this weakness. Lastly, our findings draw attention to the importance of investigating the potential bias in demographic rates by educational levels in Brazil and in other developing countries where educational expansion is underway.

This study is just the first step in revealing potential errors in census education data, and we still do not know nearly enough. Efforts need to be made to measure the magnitude and the direction (overreporting and underreporting) of misreporting of census education data for the whole population and for subgroups. Different sources of education data could be used to estimate the amount of education misreporting and provide adjusted figures. Linkage with administrative records may help, although this type of data is rarer at older ages. At the same time, attempts to reduce misreporting of education should rely on improvements in census data collection, such as better phrasing of relevant and comparable questions over time and the reduction of omission rates.

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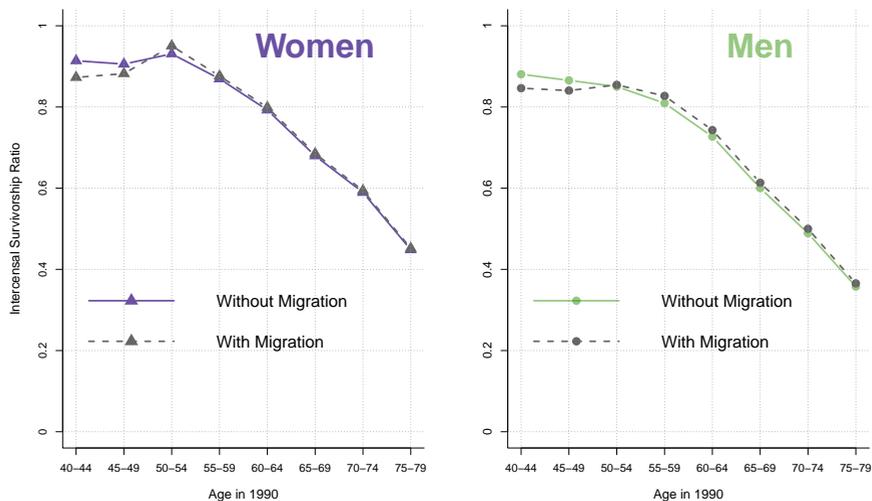
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Appendix

We ran a sensitivity analysis to investigate the potential effect of international net migration rates on our estimates. To do this, we obtained net migration rates by age and sex, estimated by Carvalho and Campos (2006), and recalculated ISR. International net migration rates are not available by educational levels in Brazil, so the sensitivity results are only for the total population. Figure A-1 shows that the effect of international migration is slightly higher at younger ages, but overall, the changes are negligible.

Figure A-1: Intercensal survivorship ratio by age: Brazil, women and men, 1990–2000



Source: Census data (IPUMS-I 2019) and Carvalho and Campos (2006).