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Research Article

**The number of centenarians in Brazil:
Indirect estimates based on death certificates**

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The number of centenarians in Brazil: Indirect estimates based on death certificates

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Abstract

The Brazilian population is rapidly aging. As a result, the number of centenarians has grown steadily, about 77 per cent between 1991 and 2000. Although expected, the increasing number of centenarians may be exaggerated by data quality issues. We compare the recorded centenarian population in the 1991 census with indirect estimates based on the extinct generation method. We find three times more people in the census than according to the indirect estimates. Uncertainty about the true size of old-age populations has important implications in data-deficient countries, particularly in the estimation of adult mortality.

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1. Introduction

According to census data, there were 24,576 centenarians living in Brazil in the year 2000, about 1.8 times more than in 1991 (IBGE 1991, 2000). The United Nations projects the centenarian population will keep increasing rapidly, almost sevenfold by 2050, when it will reach 160,000 people (United Nations 2007). These figures are not necessarily surprising when compared to those from populations where the demographic transition started earlier. In the last 50 years, the population above age 100 has grown very fast in Canada (Bourbeau and Lebel 2000), France (Vaupel and Jeune 1995, Vallin and Meslé 2001), the U.S. (Krach and Velkoff 1999, Kestenbaum and Ferguson 2005), and in many other countries (Human Mortality Database 2008).

High fertility levels in the past (Frias and Carvalho 1994; United Nations 2007) combined with fast declining mortality rates at older ages (Campos and Rodrigues 2004) have certainly allowed a much larger number of people to survive to the age 100 and older in Brazil. However, we remain skeptical about the population counts reported by the Brazilian census bureau. At older ages, data are beset with a variety of problems in many populations (Coale and Kisker 1986, Kannisto 1988, Coale and Caselli 1990, Preston, Elo, and Stewart 1999, Thatcher, Kannisto, and Andreev 2002), and there is no reason to believe these errors are absent or less frequent in Brazil. Indeed, a simple inspection of the ratio of the population aged 100 and older to 85 reveals notable discrepancies between Brazil and other selected countries of presumably higher quality data (Table 1). For example, in 1991, there were 16 centenarians per 100 people at age 85 in Brazil, eight times more than in Sweden. While comparing relative cohort sizes across populations can be misleading, because of differences in fertility and migration rates, the disparities are large enough to suggest a possible overstatement of age in the Brazilian census data.

In this article, we evaluate the quality of the census data by comparing the recorded centenarian population in the 1991 census with indirect estimates based on the method of extinct generations. The question studied here is not only relevant because Brazil is a large and rapidly aging country, but also because it reveals inconsistencies between deaths and population counts that have implications for the estimation of adult mortality in data-deficient countries.

Table 1: Ratio of the population aged 100+ to 85, by sex, selected countries, 1991

Country	Pop ₁₀₀₊ /Pop ₈₅		
	Women	Men	Both Sexes
USA	6.92	3.23	5.78
France	3.04	1.00	2.42
Sweden	2.46	1.20	2.04
Italy	1.96	1.13	1.70
Japan	1.77	0.85	1.45
Brazil	18.96	11.35	15.95

Sources: Human Mortality Database (2008), IBGE – Census Data 1991.

2. Materials

Our approach follows the method of extinct generations to reconstruct the centenarian population from cohort mortality data (Coale and Caselli 1990; Elo and Preston 1994; Bourbeau and Lebel 2000, Thatcher, Kannisto, and Andreev 2002). Assuming international migration is negligible, we accumulate the number of cohort deaths to persons at ages above 100, from 1991 to 2006, to estimate the number of centenarians by sex, as of January 1st of 1991.

Deaths come from the Mortality Information System of the Ministry of Health (SIM/Datasus). The SIM is a database that contains information about persons who died since 1979 in Brazil. Because the data are available only by age and period, we assume deaths to be distributed evenly by time of occurrence and decedent's age to calculate cohort deaths at each age-period. Earlier studies that were based on indirect methods suggest that 13 and 17 percent of deaths were missing from the SIM, respectively for adult men and women, on average, during the 1990-2000 period (Paes 2005). Although one could expect the under-registration of deaths to vary among adult ages (Hill and Choi 2004), we are not aware of any study or empirical evidence that qualifies this issue for the extreme aged in Brazil. Therefore, we use the above mentioned sex-specific under-registration estimates to adjust the volume of centenarian deaths in our study.

The application of the method of extinct generations requires waiting until the cohort is extinct. The last year of the SIM data available is 2006 and thus, the 1991 centenarian cohort attained ages 115 and older by the end of the observation period.

Empirical evidence suggests that only very few people would be alive at such advanced ages. For example, data from the Gerontology Research Group shows that out of 1,059 verified supercentenarians cases recorded, only 23 were 115 years and older (Young 2008). In addition, in Brazil, we counted only ten deaths at ages 115 and older (not validated for age accuracy) in 2006. Therefore, with only very minor effects to our estimates, we assume the 1991 cohort was extinct by the end of 2006.

We compare the indirect estimates to population counts, which are based on the entire 1991 Brazilian census data. Because the census was held at September of 1991, we use the mean annualized growth rate for centenarians, between 1991 and 2000, to estimate the corresponding population in January 1st of 1991.

3. Findings and discussion

The method described above produced the estimated number of centenarians by sex shown in Table 2. The number of centenarians estimated indirectly (4,439) is only one third the number recorded in the 1991 census (13,296). The ratio of estimated to reported population is similar for both men and women, although it is slightly lower for men (0.299 vs. 0.351), suggesting the discrepancies in the data sources are not entirely independent of sex. Not surprisingly, both estimated and reported numbers are consistent in showing there are about twice as more female than male centenarians in 1991.

Table 2: Centenarian Population of Brazil, recorded and estimated from deaths, by sex, 1991

	Recorded Population	Estimated Population	Absolute Difference	Estimated / Recorded
Men	4,382	1,311	(3,071)	0.299
Women	8,914	3,128	(5,786)	0.351
Total	13,296	4,439	(8,857)	0.334

These results reinforce our doubts about the validity of age reporting in the census data. In the 1991 census, information on age was derived from two questions. The first

one asked for the month and year of birth of the person. A second question asked for the presumable age in years and months and was used when the person did not know her date of birth. Missing data for individuals who did not answer any of the two questions were imputed by the bureau of census using the Fellegi-Holt model for statistical data editing (IBGE 2002). Although it is not possible to identify the imputed cases in the 1991 census, data from the last census, held in 2000, show that 65% of the centenarians have their age imputed by the census bureau. Therefore, poor quality information at advanced ages is probably due not only to age misreporting among those who answered the census age questions, but also due to the imputation of missing data on age.

Deaths are also susceptible to errors and therefore, we cannot rely on indirect estimates alone to supply the true number of centenarians. In addition to the under-registration of deaths, for which we attempted to correct our data, death certificates may be also subject to age misreporting. Although improbable, our indirect estimates could be biased downwards if ages at death were more frequently understated than overstated among the extreme aged in Brazil.

While the number of deaths is not recorded quite precisely in Brazil, the discrepancies shown in this article are large enough to suggest the centenarian population is exaggerated in the census. The consequences of these results are not limited to the size of the population. The inconsistencies between deaths and the recorded population imply that the mortality rate for centenarians, calculated in the conventional manner by dividing deaths by population counts, is most likely to be underestimated in Brazil. Accordingly, if we assumed the registration of deaths were accurate, the true death rate would be three times larger than the conventional one. The bias could be smaller or even larger depending on how poorly age is reported in the death certificates.

Whether these inconsistencies apply also to younger ages remains unknown, although earlier studies on adult mortality in Latin America suggest there is every reason for believing that this is probably the case for Brazil (Dechter and Preston 1991; Rosenwaik and Preston 1984; Grushka 1996). Only further research on the quality of age reporting in vital statistics and census data will help us determine at which age mortality rates become seriously flawed in Brazil.

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References

- Bourbeau, R. and Lebel, A. (2000). Mortality statistics for the oldest-old: an evaluation of Canadian data. *Demographic Research* 2(2): 1-36. doi:10.4054/DemRes.2000.2.3.
- Campos, N. O. B. and Rodrigues, R. N. (2004). Ritmo de declínio nas taxas de mortalidade dos idosos nos estados do Sudeste, 1980-2000. *Revista Brasileira de Estudos Populacionais* 21(2): 323-342.
- Coale, A. J. and Caselli, G. (1990). Estimation of the number of persons at advanced ages from the number of deaths at each age in the given year and adjacent years. *Genus* LXV (½): 1-23.
- Coale, A. J. and Kisker, E. E. (1986). Mortality Crossovers: Reality or Bad Data? *Population Studies* 40: 389-401. doi:10.1080/0032472031000142316.
- Dechter, A. R. and Preston, S.H. (1991). Age Misreporting and its effects on adult mortality estimates in Latin America. *Population Bulletin of the United Nations* (31/32): 1-16.
- Elo, I. T. and Preston, S. H. (1994) Estimating African-American mortality from inaccurate data. *Demography* 31(3): 427-458. doi:10.2307/2061751.
- Frias, L.A.M. and Carvalho, J.A.M. (1994). Uma avaliação da fecundidade no Brasil, ao início do século. *Revista Brasileira de Estudos Populacionais* 9(2): 193-199.
- Fundação Instituto Brasileiro de Geografia e Estatística – IBGE (1991). Características gerais da população e instrução, Brasil. *Censo Demográfico 1991* 1: 161.
- Fundação Instituto Brasileiro de Geografia e Estatística – IBGE (2000). Características da população e dos domicílios, Brasil. Resultados do Universo. *Censo Demográfico 2000*: 69.
- Fundação Instituto Brasileiro de Geografia e Estatística – IBGE (2002). Censo Demográfico 2000. *Metodologia do Censo Demográfico 2000*.
- Grushka, C. (1996) Adult and Old Age Mortality in Latin America: evaluation, adjustments and a debate over a distinct pattern. [Ph.D. Dissertation]. University of Pennsylvania.
- Hill, K. and Choi, Y. (2004). *Death distribution methods for estimating adult mortality: sensitivity analysis with simulated data errors*. Paper Presented at AMDC Meeting, Berkeley, California, United States, July 2004.

- Human Mortality Database (2008). Human Mortality Database [electronic resource]. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). <http://www.mortality.org>.
- Kannisto, V. (1988). On the survival of centenarians and the span of life. *Population Studies* 42: 389-406. doi:10.1080/0032472031000143546.
- Kestenbaum, B. and Ferguson, B. R. (2005). *Number of centenarians in the United States 01/01/1990, 01/01/2000, and 01/01/2010 based on improved Medicare data*. Paper presented at Population Association of America, Philadelphia, Pennsylvania, March 31 – April 2 2005.
- Krach, C.A. and Velkoff, V.A. (1999). Centenarians in the United States. U.S. Bureau of the Census, *Current Population Reports*: 23-199.
- Paes, N. A. Avaliação da cobertura dos registros de óbitos dos estados brasileiros em 2000. (2005). *Revista de Saúde Pública* 39(6): 882-290. doi:10.1590/S0034-89102005000600003.
- Preston, S.H., Elo, I.T. and Stewart, Q. (1999). Effects of Age Misreporting on Mortality Estimates at Older Ages. *Population Studies* 53(2): 165-177. doi:10.1080/00324720308075.
- Rosenwaike, I. and Preston, S. H. (1984). Age Overstatement and Puerto Rican Longevity. *Human Biology* 56(3): 503-525.
- Thatcher, R., Kannisto, V., and Andreev, K. (2002). The survivor ratio method for estimating numbers at high ages. *Demographic Research* 6: 1-18. doi:10.4054/DemRes.2002.6.1.
- United Nations (2007). Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2005 Revision*. New York: United Nations, 2007. Available at: <http://esa.un.org/unpp/index.asp?panel=2>.
- Vallin, J. and Meslé, F. (2001). Vivre au-delà de 100 ans. *Population & Sociétés* 365: 1-4.
- Vaupel, J.W. and Jeune, B. (1995). The emergence and proliferation of centenarians. In: Jeune, B. and Vaupel, J.W. (eds.). *Exceptional Longevity: from prehistory to the present*. Rostock: Odense University Press.
- Young, R. (2008). Gerontology Research Group Chief Claims Investigator. Table I: Chronological Listing of all Supercentenarians Listed by Date of Death (Sorted

by Year). [electronic resource]. <http://www.grg.org/Adams/I.HTM> (accessed Jan. 30, 2009).