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Mortality tables for the Brazilian insured population*

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This paper describes the construction of the BR-EMS 2015 mortality tables for the Brazilian insured population. The tables were based on data collected from insurance companies which represent about 80 per cent of the Brazilian insurance market, and they are updates of their previous versions, BR-EMS 2010, which have been the first mortality tables built with Brazilian market experience. Additional data from government sources was used to improve the information of the companies' databases. The mortality rates of the population under risk products (death coverage) are remarkably different than those under savings products (survivorship coverage); as such, four different mortality tables are constructed, separating the population by sex as well as the type of insurance coverage. A straight comparison between the BR-EMS 2015 tables with the statistics of the general Brazilian population shows a striking difference on life expectancies. The BR-EMS 2015 tables are also compared with other life tables.

Keywords: Life tables. Mortality. Death rate. Insurance market. Heligman-Pollard.

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Introduction

Over the past few decades, the Brazilian insurance market has expanded at an accelerated rate. Insurance companies operating in Brazil had to resort to foreign and outdated mortality tables in their actuarial analysis and computations, such as the American Annuity 2000 Mortality Table, AT-2000 (JOHANSEN, 1995), since there were no local life tables available based on the Brazilian insurance market.

Following several joint initiatives from the Brazilian government and insurance companies, the Brazilian association of insurance and pension companies, FenaPrevi,[1] through an agreement with the LabMA/UFRJ[2] research group, commissioned the construction of mortality tables for the Brazilian insurance market. The Brazilian regulatory agency for the insurance market, SUSEP,[3] determined the first version of these tables, named BR-EMS 2010 (for "*Experiência do Mercado Segurador Brasileiro*" — Experience of the Brazilian insurance market), as the as the new official standard tables for the Brazilian insurance market. BR-EMS 2010 tables are separated by sex and type of insurance coverage: survivorship (pertaining to old-age pensions) and death (risk products), since the death rates for these two insured groups were shown to be clearly distinct. These tables were built using data from 13 insurance company groups (amounting to about 80 per cent of the Brazilian insurance market) from 2004 to 2006, comprising more than 39 million individuals. The process of building these tables was detailed in the book (DE OLIVEIRA et al., 2012b), which also has an English version (DE OLIVEIRA et al., 2012a).

In 2015, BR-EMS tables were reviewed in order to stay up-to-date with the most current mortality information available at the time. The new version, named BR-EMS 2015, is the current standard for the Brazilian insurance market, published in (SUPERINTENDÊNCIA DE SEGUROS PRIVADOS, 2015). In this revision, data from 2007 to 2012 was incorporated, comprising more than 83 million individuals.

The goal of this paper is to describe and analyse the methodology employed in the construction of Brazilian insurance market tables and perform a comparison with well-established native and foreign mortality tables. Due to the large amount of collected data, parametric models were not used for the entire age range. Instead, we applied a sequence of moving averages to the intermediate age interval in order to smooth the crude rates. We also applied logit patching and exponential fitting to smooth the connection of the extreme age intervals to the middle one.

BR-EMS 2015 tables were compared with mortality tables issued by the Brazilian Institute of Geography and Statistics, IBGE,[4] for the general Brazilian population. The results

[1] In Portuguese, *Federação Nacional de Previdência Privada e Vida*.

[2] The Applied Mathematics Laboratory of the Rio de Janeiro Federal University. In Portuguese, *Laboratório de Matemática Aplicada da Universidade Federal do Rio de Janeiro*.

[3] In Portuguese, *Superintendência de Seguros Privados*.

[4] In Portuguese, *Instituto Brasileiro de Geografia e Estatística*.

show a striking difference between both groups of tables, which reflects the improved socioeconomic conditions of the Brazilian insured population. We also compared other life tables , such as the aforementioned AT-2000, the Chilean table for the insured market, and RV-2009 (SUPERINTENDENCIA DE PENSIONES, 2010), as well as other foreign tables.

The present paper is organized as follows: in section 2, the insurance companies' databases and effects of their aggregation with government databases are described in more detail, along with some demographic features of the studied population. Section 3 details procedures used to build the curve of death probabilities from crude rates obtained from data. Section 4 contains BR-EMS 2015 tables compared with their previous version, BR-EMS 2010, and with different tables from around the world. Final considerations are shown in section 5.

The database

This section describes the whole series of annual data collected from 2004 to 2012 from the 13 insurance company groups participating in the Brazilian mortality tables study commissioned by FenaPrevi. All of this private data was provided to LabMA/UFRJ under a confidentiality agreement with FenaPrevi and the company groups involved.

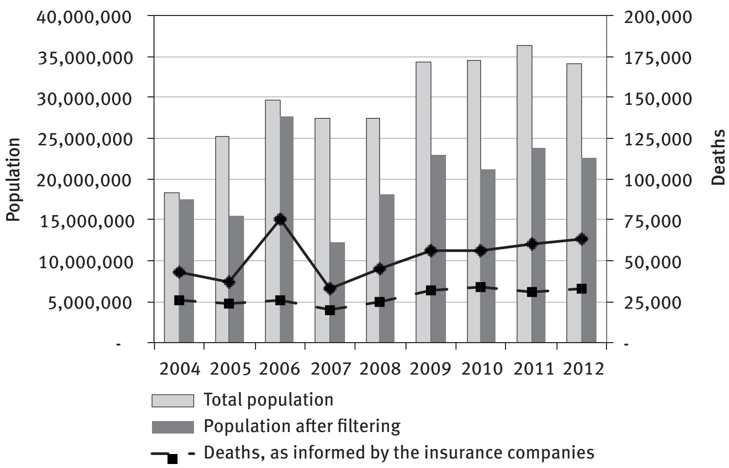
BR-EMS 2010 tables used data from the three-year period ranging from 2004 to 2006, while BR-EMS 2015 used data from the period from 2004 to 2012. It is worth noting that more than 1.5 billion lines of information have been processed, from around 83 million individuals. Despite being a unique identifier, the CPF[5] (the Brazilian individual taxpayer registry identification) cannot be mapped as a key for individuals in the database, since the same CPF code is sometimes used for individuals from the same family in the companies' databases, or even within the same group of clients of an insurance agent. Thus, in this study, insured individuals were modelled using their attributes of birth date, sex, and CPF, with the extra precaution of allowing only a limited number of individuals with the same CPF code.

During data processing, it was also necessary to deal with undercounting and imprecision of death records of the companies' databases. For instance, sometimes the death of an individual is not reported by the insurance company, or the death event is misreported as the end of his/her contract (and vice versa). Such data inconsistencies required all informed data records to be checked against the official Brazilian social information databases, *Cadastro Nacional de Informações Sociais* (CNIS) and *Sistema Nacional de Óbitos* (SISOBI), which have, respectively, information for all pension payments made by the Brazilian Social Security Institute and all deaths registered at all government notary offices in the country. Data from CNIS and SISOBI were obtained through a cooperation agreement with their legal holder, the Brazilian Ministry of Social Security (*Ministério da Previdência Social*).

[5] In Portuguese, *Cadastro de Pessoas Físicas*.

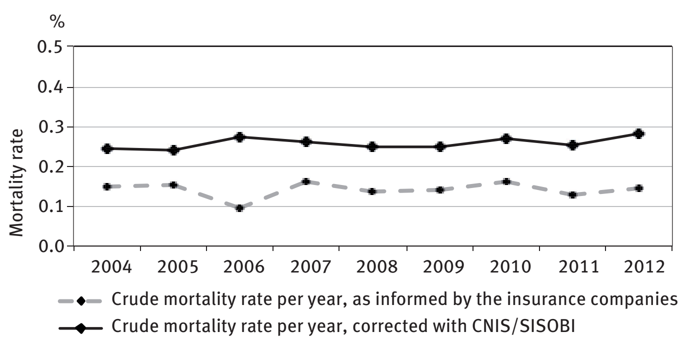
Graph 1 shows annual counts of exposed individuals and deaths, and Graph 2 shows crude mortality rate for each calendar year, which remained stable around 0.26 per cent throughout the years. One can notice a steady growth in the number of exposed individuals, reflecting recent expansion of the Brazilian insurance market along the period. The fluctuations observed in Graph 1 reflect a loss of information due to specific insurance companies' database problems in particular years. Graph 1 also shows that the correction provided by the government databases equals 34 per cent of the amount reported by the companies. This represents a fundamental improvement for the computation of the mortality tables.

GRAPH 1
Insured population (before/after data filtering) and number of death records (before/after correction with CNIS/SISOBI data)
Brazil – 2004-2012



Source: Brazilian insurance companies participating in the analysis, CNIS, and SISOBI.

GRAPH 2
Crude mortality rates of insured individuals (before/after correction with CNIS/SISOBI data)
Brazil – 2004-2012



Source: Brazilian insurance companies participating in the analysis, CNIS, and SISOBI.

Table 1 shows exposed individuals of Graph 1 in greater detail, classified by sex and type of insurance coverage: death (pertaining to risk products) and survivorship (pertaining to old-age pensions and savings products). In our analysis, all individuals who have both coverages are considered to belong to the survivorship group only. As one can see in section 4, mortality tables for these groups show a clear separation between death and survivorship coverages. Table 1 also shows that death coverage accounts for more than four times as many individuals as survivorship coverage.

TABLE 1
Insured population by type of insurance coverage and sex (/1,000)
Brazil – 2004-2012

Years	Death (1)		Survivorship (2)	
	Females	Males	Females	Males
2004	5,469	7,965	1,928	2,927
2005	9,343	11,060	2,012	2,709
2006	10,799	13,715	2,238	2,914
2007	9,956	12,275	2,326	2,990
2008	8,530	13,282	2,485	3,148
2009	12,528	16,732	2,246	2,803
2010	11,146	17,835	2,278	3,215
2011	12,057	18,953	2,280	3,167
2012	10,667	17,109	2,741	3,684

Source: Brazilian insurance companies participating in the analysis.
(1) Risk products.
(2) Old-age pensions.

Regarding territorial distribution of the studied population, the total number of individuals in the five geographical regions of Brazil is shown in Table 2. Notice that more than 70 per cent of the population belongs to the most socioeconomically developed regions, the South and Southeast, where about 28 per cent of the population participates in the insurance market (Note: the data represent about 80 per cent of the Brazilian insurance market). It can also be inferred that the Brazilian insured population corresponds to around 22 per cent of the entire Brazilian population in 2012, which is a small proportion compared to more developed countries.

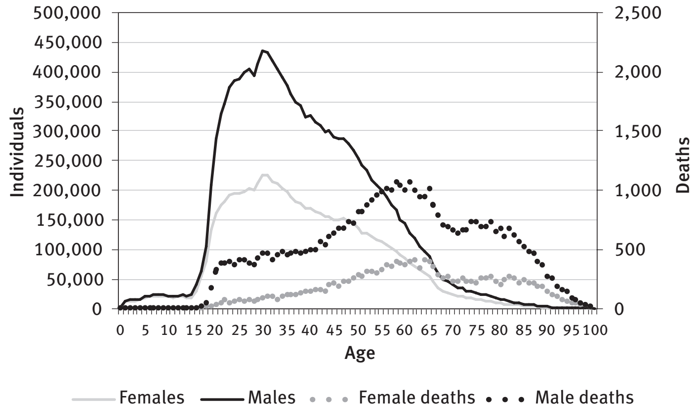
TABLE 2
Insured and general population by region and type of insurance coverage (/1,000)
Brazil – 2012

Zones	Death (1)		Survivorship (2)		Both coverages		Brazilian population	
	N	%	N	%	N	%	N	%
Southeast	14,319	51	3,973	61	18,292	53	81,566	42
South	5,164	19	1,081	17	6,245	18	27,732	15
Northeast	4,849	17	783	12	5,632	17	53,907	28
Central-West	2,329	8	430	7	2,759	8	14,424	7
North	1,237	5	195	3	1,432	4	16,318	8
Total	**27,897**	**100**	**6,462**	**100**	**34,359**	**100**	**193,947**	**100**

Source: Brazilian insurance companies participating in the analysis; IBGE. Censo Demográfico 2010.
(1) Risk products.
(2) Old-age pensions.

Graph 3 shows the population under study for the year 2012 distributed by age and sex. Almost three-fourths of this population is concentrated between the ages of 20 and 50, and the maximum number of deaths is at age 58 for males and 62 for females. The decrease at ages 82 and over is due to the much smaller number of insured elderly people.

GRAPH 3
Distribution of number of insured individuals and deaths by age and sex
Brazil – 2012



Source: Brazilian insurance companies participating in the analysis, CNIS, and SISOBI.

Table 3 shows the distribution of the Brazilian insured population under study for all years, highlighting the very low figures regarding the extreme age groups (i.e., young and old individuals). This is particularly true for the age 80 or above, which, as we shall see in the next section, is essential for completion of the table.

TABLE 3
Number of insured individuals at young and old ages (/1,000)
Brazil – 2004-2012

Years	Age 18 years				Age 60 years				Age 80 years			
	Males		Females		Males		Females		Males		Females	
	N	%	N	%	N	%	N	%	N	%	N	%
2004	285	2.6	240	3.3	946	8.7	704	9.5	48	0.4	31	0.4
2005	385	2.8	336	3.0	1,194	8.7	1,202	10.6	67	0.5	63	0.6
2006	444	2.7	390	3.0	1,571	9.4	1,529	11.7	105	0.6	98	0.8
2007	477	4.4	406	5.9	929	8.5	676	9.8	65	0.6	52	0.8
2008	510	3.8	439	5.1	1,242	9.3	915	10.7	87	0.7	75	0.9
2009	459	2.5	397	3.0	1,622	9.0	1,360	10.3	90	0.5	75	0.6
2010	535	2.5	446	3.3	2,048	9.7	1,612	12.0	134	0.6	104	0.8
2011	612	2.8	511	3.6	2,842	12.8	2,382	16.6	214	1.0	200	1.4
2012	649	3.1	568	4.2	2,921	14.0	2,486	18.5	246	1.2	246	1.8
Total	**4,355**	**3.0**	**3,734**	**3.7**	**15,315**	**10.4**	**12,865**	**12.7**	**1,055**	**0.7**	**944**	**0.9**

Source: Brazilian insurance companies participating in the analysis.

Methodology for computing the mortality tables

Annual mortality rates

Data provided by insurance companies still contained inaccuracies and inconsistencies even after correction using data from CNIS/SISOBI. The set of problematic data needed to be filtered out using reliable criteria. In this section, procedures used to filter data and compute crude mortality rates corresponding to the years 2007-2012 are detailed. Part of these procedures is also described in (DE OLIVEIRA et al., 2012a).

First, clearly inconsistent records were discarded, such as those containing:

- Invalid CPF, date of birth or death;
- Wildcard CPF (i.e., CPF shared by more than four different individuals in the database);
- Date of death preceding the beginning of the insurance contract or birth date.

Second, individuals were sorted into different subpopulations, which are defined as groups of individuals with the same sex, coverage (death or survivorship), insurance company, and acquired insurance product, in the same calendar year. This grouping was necessary because there is a clear separation between the mortality tables for males and females, and also between individuals with different coverages of the same sex. Additionally, it allows filtering out inconsistent data records and unbalanced insurance products in a more precise way, since the same company may report problematic data for some products but not others.

Next, the subpopulations were statistically filtered in order to exclude outliers (which may correspond to problematic data). This filtering method only makes sense for statistically relevant groups; for this reason, subpopulations with fewer than 1000 individuals were discarded. Each remaining subpopulation was then grouped by sex and coverage, and with similar subpopulations from the past two calendar years (e.g., to filter the subpopulations corresponding to the annual table of 2008, subpopulations of 2006 and 2007 were also taken into consideration). This was done to avoid large gaps between annual tables for consecutive years.

In order to compare these subpopulations and filter out those with too many or too few death records, two extreme mortality tables were used as a basis of comparison, namely:

- IBGE Complete Mortality Tables 2005, based on mortality in Brazil's general population in 2005, which has higher mortality rates than the Brazilian insured population (IBGE, 2005). This table was continuously extended to 103 years for use in the filtering process.
- CSO 2001 Valuation Basic Table, which has low mortality rates, based on some US insurance companies' 1990-1995 mortality experience , projected to 2001 (AMERICAN ACADEMY OF ACTUARIES, 2002).

For each subpopulation s, the ratio between the observed and the theoretical number of deaths under each of the extreme tables, denoted by $r_{s,e}$, is defined as:

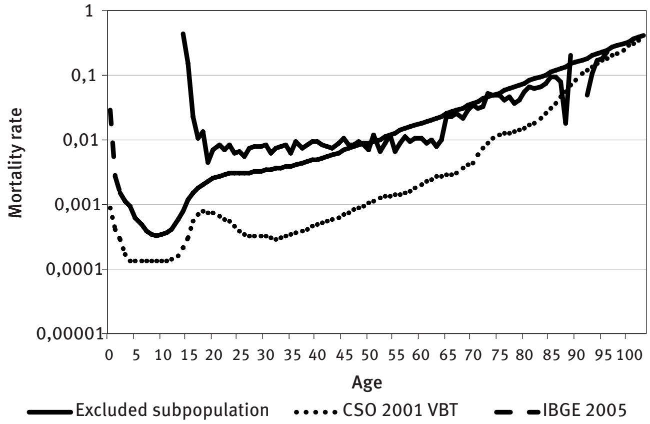
$$r_{s,e} = \frac{o_s}{\sum_x q_{e,x} E_{s,x}}, \quad (1)$$

where o_s is the total observed number of death records of subpopulation s, $q_{e,x}$ is the probability of death at age x in extreme table e, and $E_{s,x}$ denotes the number of individuals at age x in subpopulation s. When $r_{s,e}$ is close to 1, this means that the mortality rate of subpopulation is close to the rate of extreme table e.

If all subpopulations have about the same mortality pattern, then all values of $r_{s,e}$ should be roughly near a central value and close to each other. Subpopulations with $r_{s,e}$ very different from the central value should be discarded, as they probably involve data errors. Since the numerator of each fraction $r_{s,e}$ is the actual number of deaths for each subpopulation, and since the number of deaths, considered as a random variable, is the sum of independent binomial random variables (one for each age), one may assume that the numerator of each fraction will be approximately normally distributed. As such, Tukey's fences (TUKEY, 1977) were applied to the ratios $r_{s,e}$ in order to define and discharge outlier subpopulations, via an iterative process that was repeated until all outliers ceased to exist. For the present case, each bound was established by adding and subtracting 1.5 inter-quartile distances from the median, leaving roughly 95 per cent of the subpopulations unaffected.

After this statistical filtering, the remaining subpopulations were further examined, in order to visually detect and discard those for which mortality rates greatly diverged from the expected mortality pattern for human populations. Graph 4 shows an example of an insurance company/product subpopulation that was excluded from the final population due to its over mortality with respect to the IBGE 2005 table, and its non-increasing mortality rates over the age interval from 20 to 65 years, which is not an expected mortality pattern. This indicates a likely error in the death records.

GRAPH 4
Example of an excluded subpopulation in the data filtering process



Source: Brazilian insurance companies participating in the analysis, CNIS, and SISOBI; American Academy of Actuaries: CSO Task Force Report, 2002; IBGE: Complete Mortality Tables, 2005.

Graph 1 shows the extent of this data filtering process for each year from 2004 to 2012. It shows the great impact filtering has on the amount of data used for the construction of BR-EMS tables. For instance, in 2012 approximately 34 per cent of individuals were discarded due to data filtering.

After all subpopulations were filtered, the death probability $q^y_{c,s,x}$ for year y for the population with coverage c and sex s at age x was estimated by the mortality rate, as follows:

$$\hat{q}^y_{c,s,x} = \frac{d^y_{c,s,x}}{E^y_{c,s,x}}, \tag{2}$$

where $d^y_{c,s,x}$ is the total number of deaths and $E^y_{c,s,x}$ is the total exposition (i.e., respectively the sum of deaths and exposition of all remaining subpopulations with coverage c and sex s of calendar year y).

BR-EMS 2015 tables

The procedure detailed in the previous section was used to obtain annual mortality rates $\hat{q}^y_{c,s,x}$ for the years 2007 to 2012. For each coverage c and sex s, the crude mortality rates of BR-EMS 2015 tables, $\hat{q}^{BR15}_{c,s,x}$, were then estimated as an exponentially weighted average of $\hat{q}^y_{c,s,x}$ and the corresponding BR-EMS 2010 table entry $\hat{q}^{BR10}_{c,s,x}$, namely,

$$\hat{q}^{BR15}_{c,s,x} = \frac{\hat{q}^{2012}_{c,s,x}}{2} + \frac{\hat{q}^{2011}_{c,s,x}}{4} + \frac{\hat{q}^{2010}_{c,s,x}}{8} + \frac{\hat{q}^{2009}_{c,s,x}}{16} + \frac{\hat{q}^{2008}_{c,s,x}}{32} + \frac{\hat{q}^{2007}_{c,s,x} + q^{BR10}_{c,s,x}}{64}, \tag{3}$$

This weighting emphasizes the most recent information, because the most current value $\hat{q}^{2012}_{c,s,x}$ has the same weight as all past tables combined.

The resulting rates were graduated by applying different methods to three distinct age groups, hereafter called “younger”, “intermediate”, and “older”. The 2010 and 2015 versions of the tables differ on this point, as BR-EMS 2010 only had the Heligman-Pollard model applied to its full set of ages, from the earliest to the oldest. The separation into three age groups was necessary due to the relative scarcity of data for the younger group (as seen in Graph 3 and Table 3), and to the well-known death undercounting in the older group, as reported in Gomes and Turra (2009) and Queiroz and Sawyer (2012). More extensive modelling was required for these two groups, whereas the crude rates of the intermediate age interval exhibit smooth behaviour. The exact range of each age group by coverage and sex are:

- **Death coverage, females**. Younger: 19 and under; Intermediate: 20-99; Older: 100 and over.
- **Death coverage, males**. Younger: 16 and under; Intermediate: 17-90; Older: 91 and over.
- **Survivorship coverage, females**. Younger: 17 and under; Intermediate: 18-100; Older: 101 and over.
- **Survivorship coverage, males**. Younger: 16 and under; Intermediate: 17-96; Older: 97 and over.

For the younger group, crude rates $\hat{q}^{y}_{c,s,x}$ were graduated by a nonlinear fit to the data using a nine-parameter version of the Heligman-Pollard model (HELIGMAN; POLLARD, 1980),

$$q(x) = A^{(x+B)^C} + De^{-E(\ln x - \ln F)^2} + \frac{GH^x}{1+KGH^x} \qquad (4)$$

Due to the scarcity of data in this age interval, the sets of both death and survivorship coverage were used together to obtain the parameters.

For the intermediate group, in which most of the exposed population is concentrated, the rates $q_{c,s,x}$ were obtained by a simple moving average of length three of $\hat{q}_{c,s,x}$, followed by one of length five for further smoothing. There was no need for more extensive modelling due to the amount of good quality data available for this age group – all resulting rates are fairly smooth and monotone for this age interval, with the exception of naturally occurring humps around age 23. Rates for younger ages were then smoothly interpolated to the intermediate rates using a suggestion proposed by (BRASS, 1975), calculating a constant logit distance between the curves for males and females.

The older group had its rates $q_{c,s,x}$ generated from exponential extrapolations of the intermediate group rates. Any two different curves were forced to coincide at the age where they first met. Thus, rates for males insured under death and survivorship coverages coincide from 97 years on; rates for females insured under death coverage coincide with the two rates for males from 100 years on; and the rates for females insured under survivorship coverage coincide with the remaining rates from 117 years on.

Confidence intervals

Assuming that all individuals with the same age x die independently and with the same probability, the number of deaths in year y for coverage c and sex s, $d^{y}_{c,s,x}$, can be understood as a random variable with a binomial $B(|E^{y}_{c,s,x}|, q^{y}_{c,s,x})$ distribution, where $q^{y}_{c,s,x}$ is unknown. As before, let $\hat{q}^{y}_{c,s,x} = d^{y}_{c,s,x} / E^{y}_{c,s,x}$. Using the binomial hypothesis, and estimating $q^{y}_{c,s,x}$ with $\hat{q}^{y}_{c,s,x}$, one has the following estimate for the variance of $\hat{q}^{y}_{c,s,x}$:

$$\mathrm{Var}\,(\hat{q}^{y}_{c,s,x}) = \frac{\hat{q}^{y}_{c,s,x}(1-\hat{q}^{y}_{c,s,x})}{E^{y}_{c,s,x}} \qquad (5)$$

For a given age x, each annual rate $\hat{q}^{y}_{c,s,x}$ is assumed to be independent from the others; therefore, the variance of $\hat{q}^{BR15}_{c,s,x}$ can be estimated by the weighted sum of the variances of $\hat{q}^{y}_{c,s,x}$ and $\hat{q}^{BR10}_{c,s,x}$ (cf. Eq. 2),

$$\mathrm{Var}\,(\hat{q}^{BR15}_{c,s,x}) = \frac{\mathrm{Var}\,(\hat{q}^{2012}_{c,s,x})}{2^2} + \frac{\mathrm{Var}\,(\hat{q}^{2011}_{c,s,x})}{4^2} + \cdots + \frac{\mathrm{Var}\,(\hat{q}^{2007}_{c,s,x}) + \mathrm{Var}\,(\hat{q}^{BR10}_{c,s,x})}{64^2} \qquad (6)$$

Finally, using the normal approximation to $\hat{q}^{BR15}_{c,s,x}$, one gets the confidence interval

$$\left[\hat{q}^{BR15}_{c,s,x} - 1.96\sqrt{\mathrm{Var}(\hat{q}^{BR15}_{c,s,x})},\ \hat{q}^{BR15}_{c,s,x} + 1.96\sqrt{\mathrm{Var}(\hat{q}^{BR15}_{c,s,x})}\right] \qquad (7)$$

where 95 per cent of the values lie.

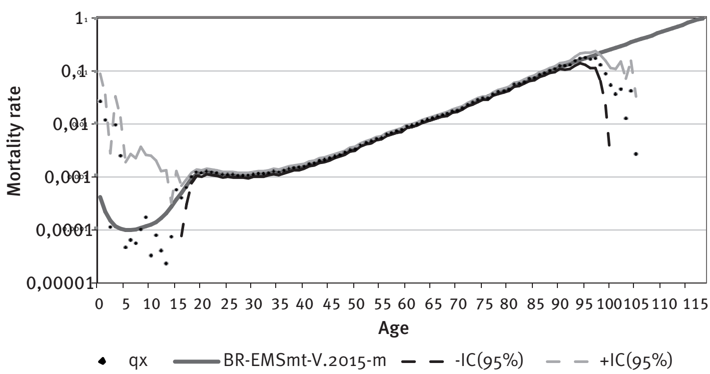
The mortality tables

In this section, BR-EMS 2015 tables are presented for both sexes and the two different types of insurance coverage: death and survivorship. The complete tables are given in Appendix A (TABLES 1 to 4), following the official nomenclatures as (SUPERINTENDÊNCIA DE SEGUROS PRIVADOS, 2015):

- Death coverage, females: BR-EMSmt-V.2015-f.
- Death coverage, males: BR-EMSmt-V.2015-m.
- Survivorship coverage, females: BR-EMSsb-V.2015-f.
- Survivorship coverage, males: BR-EMSsb-V.2015-m.

Graph 5 presents the case of males insured under death coverage. The crude rates $\hat{q}$ are shown along with the smoothed curve q_x obtained by the graduation techniques described in section 3. Note that confidence intervals between ages 20 to 90 are very tight, reflecting the large amount of data available, supporting the use of moving averages instead of the Heligman-Pollard model in the intermediate interval.

GRAPH 5
BR-EMS 2015 mortality table for the Brazilian insured population, along with crude mortality rates, and confidence intervals for males, death coverage (on logarithmic scale)
Brazil – 2015

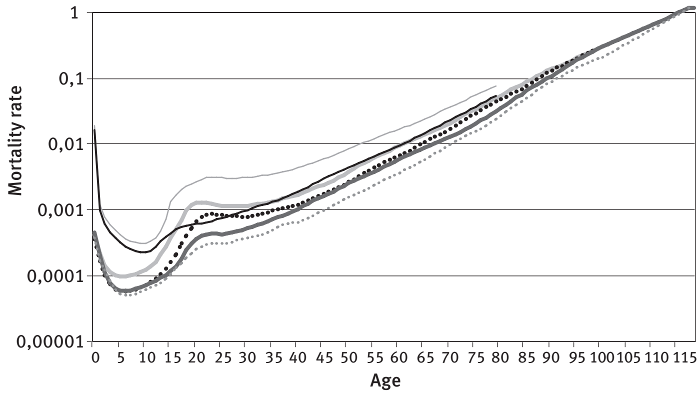


Source: Brazilian insurance companies participating in the analysis, CNIS, and SISOBI.

Graph 6 shows all four cases together with IBGE 2012 tables for the sake of comparison. One clearly notices the separation between males and females. Overmortality for males is plainly observed in both coverages, mainly around age 20, where there is a more pronounced hump in the curve due to deaths from external causes. Note that rates for death coverage are higher than rates for survivorship coverage for males and females at all ages.

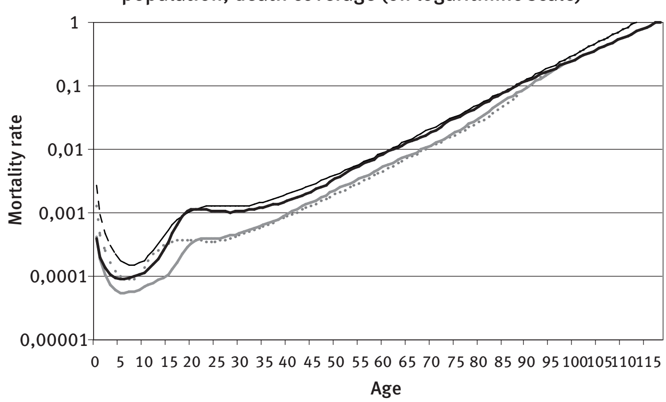
Graphs 7 and 8 present a direct comparison between the 2010 and 2015 versions of the BR-EMS tables, for death and survival coverage, respectively. Note that except for the earlier ages, intervals where mortality rates decrease may be clearly identified in both tables for males. The tables for females, on the other hand, show either stabilization or increase in mortality rates. These variations deserve further investigation.

GRAPH 6
BR-EMS 2015 mortality tables for the Brazilian insured population alongside the IBGE Complete Mortality Tables 2012 for the Brazilian general population (on logarithmic scale)



Source: IBGE: Complete Mortality Tables, 2012; Brazilian insurance companies participating in the analysis, CNIS, and SISOBI.

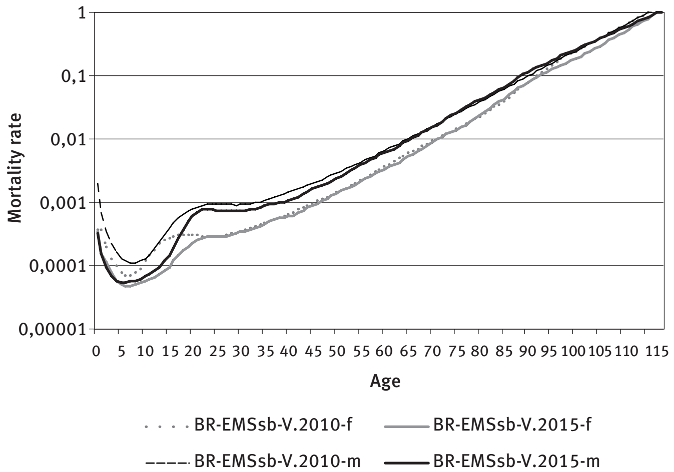
GRAPH 7
Comparison between the 2010 and 2015 versions of the BR-EMS tables for the Brazilian insured population, death coverage (on logarithmic scale)



Source: Brazilian insurance companies participating in the analysis, CNIS, and SISOBI.

Table 4 displays the difference in life expectancies when comparing the BR-EMSsb 2015, which was built with data up to 2012, with the IBGE Complete Mortality Tables 2012 (IBGE, 2012). It can be seen that the insured population in Brazil has remarkably higher life expectancy, which reflects its elevated socioeconomic conditions as compared to those of the general population.

GRAPH 8
Comparison between the 2010 and 2015 versions of the BR-EMS tables for the Brazilian insured population, survivorship coverage (on logarithmic scale)



Source: Brazilian insurance companies participating in the analysis, CNIS, and SISOBI.

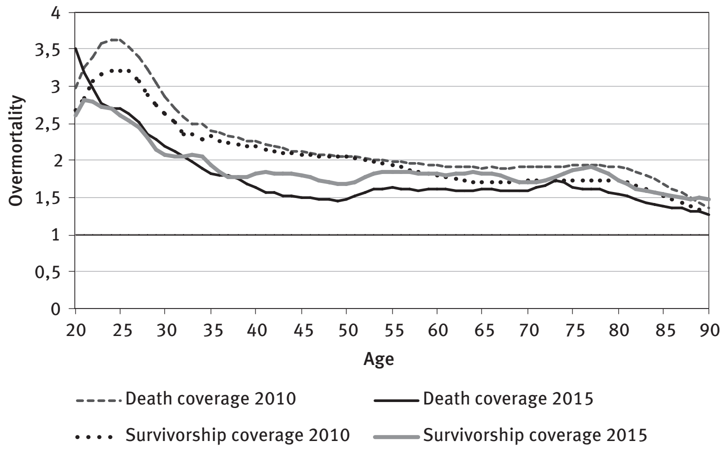
TABLE 4
Life expectation of the population under survivorship coverage according to the BR-EMS 2015 tables, and that of the Brazilian population according to IBGE 2012 tables, at ages 0, 30 and 60 (in years)

Sex	Age	IBGE 2012	BR-EMS 2015 Survivorship	Difference between BR-EMS 2015 and IBGE 2012
Females	0	78.3	87.8	**9.5**
	30	50.3	58.1	**7.8**
	60	23.3	29.5	**6.2**
Males	0	71	82.4	**11.4**
	30	44.4	53	**8.6**
	60	19.8	25.1	**5.3**

Source: IBGE. Complete Mortality Tables, 2012; Brazilian insurance companies participating in the analysis, CNIS, and SISOBI.

The curves of Graph 9, starting at age 20, show the decrease of overmortality for males during the period between the 2010 and 2015 tables. This is seen more distinctly in life insurance coverage for all age intervals. Note that in the 2010 tables, survivorship coverage showed lower overmortality for males, a situation that was reversed in the 2015 tables.

GRAPH 9
Comparison of the overmortality for males between the 2010 and 2015 versions of the BR-EMS mortality tables for the Brazilian insured population (on logarithmic scale)



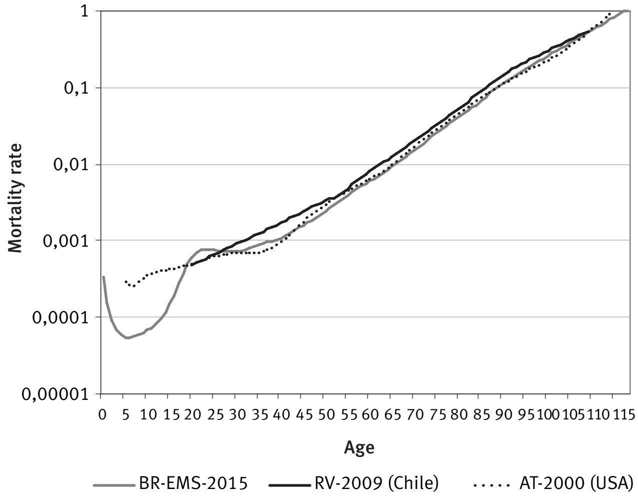
Source: Brazilian insurance companies participating in the analysis, CNIS, and SISOBI.

Comparison with other mortality tables

In order to highlight some characteristics of the Brazilian insured population under analysis, we performed some comparisons with foreign market tables, as well as with general population tables from developed countries. In Graph 10 illustrates the AT 2000 and RV-2009 tables in direct comparison with the survivorship version of BR-EMS 2015 for males. RV-2009 was constructed using the experience of the Chilean annuity market, pension funds, and the Social Security Institute (SUPERINTENDENCIA DE PENSIONES, 2010), while AT 2000 (JOHANSEN, 1995) uses data from the American individual annuity market and was the former standard for the Brazilian market before the appearance of BR-EMS 2010. Note the similarity of the BR-EMS 2015 with the AT-2000 at most of the age intervals under consideration and, similarly, its lower mortality against the Chilean RV-2009.

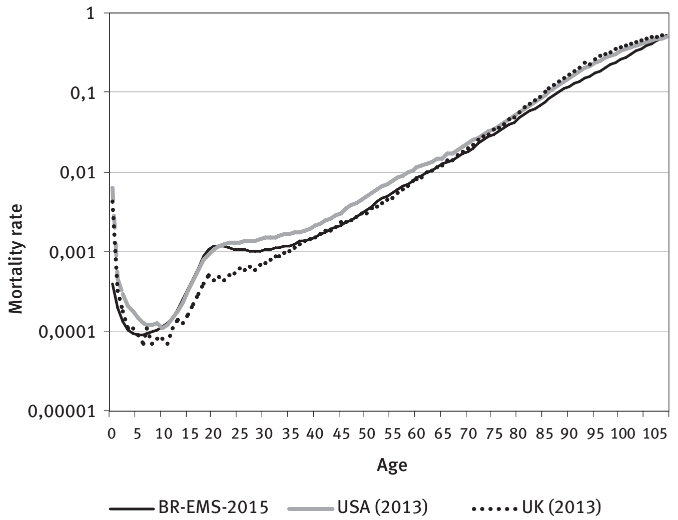
In Graph 11, mortality tables for the general population of the United States (NATIONAL CENTER FOR HEALTH STATISTICS, 2013) and the United Kingdom (OFFICE FOR NATIONAL STATISTICS, 2013) in 2013 are compared with the BR-EMS 2015 table for males insured under mortality coverage. Despite being a less developed country, the mortality rates of the insured population of Brazil are similar to ones of for the populations in these developed countries very closely. The USA and BR-EMS tables are very similar at the external-causes hump. The same is not true for the British table. On the other hand, the latter almost coincides with the Brazilian table between the ages of 35 and 70. The life expectancy of insured males as predicted by the BR-EMS 2015 is 82.9 years of age at birth, which is superior to life expectancies for the general populations in the USA and UK, which are, according to the aforementioned tables, 76.6 and 79 years of age, respectively.

GRAPH 10
Comparison between the BR-EMS 2015 table for males/survivorship coverage with other market tables



Sources: Brazilian insurance companies participating in the analysis, CNIS, and SISOBI; Superintendencia de Pensiones, Chile: Circular n. 1679/2010; Society of Actuaries, USA: Mortality and Other Rate Tables, 2016.

GRAPH 11
Comparison between the BR-EMS 2015 table for males/death coverage with foreign tables (UK and USA)



Source: Brazilian insurance companies participating in the analysis, CNIS, and SISOBI; National Center for Health Statistics, USA: Multiple Cause of Death Public Use File, 2006 (2013); Office for National Statistics, UK: Deaths by sex and single year of age until the last age 110+, 2013.

Conclusions

This paper describes the database and procedures used to construct BR-EMS mortality tables, which were the first ones compiled from Brazilian market experience data. Despite being more focused on the 2015 version, this paper also contains an account of the design of BR-EMS 2010 via a direct comparison between the two versions. For instance, the newer version showed improvements with regards to the amount and quality of collected data from the participating insurance companies.

The database contains over a billion records, from which information on around 83 million insured individuals was compiled, allowing the elaboration of four distinct tables, classified under sex and insurance coverage types (death or survivorship). The whole database has been scrutinized and checked against official government social information databases, which proved to be a necessary step for the accuracy of a large part of the collected data.

For the construction of BR-EMS 2010 and 2015 tables, data were first classified into subpopulations separated by calendar year, company, product, sex, and type of insurance coverage. These subpopulations were filtered using various exclusion criteria, ranging from possessing a small number of individuals to having a nonstandard mortality pattern. Afterwards, outliers were further excluded using Tukey's fences. The remaining groups of subpopulations were merged, giving rise to the final population from which all death rates were obtained. The Heligman–Pollard model was then used to graduate the set of obtained rates; however, distinctly from BR-EMS 2010, which was entirely fitted with this model, the 2015 version used parametric models only at the extreme age groups. In the range between 18 and 90 years, only moving averages were used, due to the smooth behaviour exhibited by crude rates in this interval.

Mortality tables for the Brazilian insured population were shown to be much lower than those for the Brazilian general population, and more akin to those for more developed countries, such as the USA and UK. This reflects the fact that only about 22 per cent of the Brazilian population – which can be assumed to have a higher socioeconomic level compared to the rest of the population – has some kind of insurance contract.

As future studies, we cite the investigation of mortality trends at older ages, which will depend on insurance companies providing further and more specific; analysis of mortality rates in different regions of Brazil, which may improve insurance companies' underwriting experience; and analysis of the changes in mortality rates for the Brazilian insured population over the years.

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Resumo

Tábuas de mortalidade para a população brasileira de segurados

Este artigo descreve a construção das tábuas de mortalidade BR-EMS 2015 para a população brasileira de segurados. As tábuas foram elaboradas a partir de dados coletados de companhias de seguros que representam 80% do mercado segurador brasileiro e são atualizações das tábuas BR-EMS 2010, que foram as primeiras tábuas de mortalidade a serem produzidas usando-se a experiência do mercado segurador brasileiro. Informações adicionais de fontes governamentais foram utilizadas para complementar e melhorar as informações fornecidas pelas companhias de seguros. As taxas de mortalidade da população contratante de produtos com cobertura de morte são notavelmente diferentes daquelas referentes aos contratantes de produtos de sobrevivência. Assim, quatro tábuas de mortalidade diferentes foram construídas, separando a população por sexo e também pelo tipo de cobertura de seguro. Uma comparação direta entre as tábuas BR-EMS 2015 com as estatísticas da população brasileira geral mostra uma diferença considerável nas expectativas de vida. As tábuas BR-EMS 2015 ainda são comparadas com outras tábuas de mortalidade.

Palavras-chave: Tábuas atuariais. Mortalidade. Taxa de mortalidade. Mercado segurador. Heligman-Pollard.

Resumen

Tablas de mortalidad de la población brasileña asegurada

En este trabajo se describe la construcción de las tablas de mortalidad BR-EMS 2015 para la población asegurada de Brasil. Las tablas se confeccionaron a partir de datos recogidos de las compañías de seguros que representan alrededor del 80% del mercado brasileño de seguros y son actualizaciones de sus versiones anteriores, BR-EMS 2010 —las primeras tablas de mortalidad hechas con base en la experiencia del mercado brasileño—. Se utilizó información adicional de fuentes gubernamentales para complementar y mejorar las bases de datos de las empresas. Las tasas de mortalidad de la población con contrato de productos de riesgo (cobertura de la muerte) son notablemente diferentes a las de los incluidos en los productos de ahorro (cobertura de supervivencia). Por lo tanto, cuatro diferentes tablas de mortalidad se han construido, separando la población según el sexo y el tipo de cobertura de seguro. Una comparación directa entre las tablas BR-EMS 2015 para la población asegurada de Brasil con las estadísticas de la población en general de Brasil muestra una diferencia considerable en la esperanza de vida. Las tablas BR-EMS 2015 también se comparan con otras tablas de vida.

Palabras clave: Tablas actuariales. Mortalidad. Índice de mortalidad. Mercado de seguros. Heligman-Pollard.

Appendix
BR-EMS 2015 mortality tables

TABLE 1
BR-EMS 2015 mortality table for males, survivorship coverage

BR-EMSsb-V.2015-m									
Age *x*	q_x	-IC(95%)	+IC(95%)	e_x	Age *x*	q_x	-IC(95%)	+IC(95%)	e_x
0	0.0003372	–	0.0004601	82.4	60	0.0060008	0.0055785	0.0065806	25.1
1	0.0001568	0.0000313	0.0003004	81.4	61	0.0065038	0.0057443	0.0068260	24.3
2	0.0000941	0.0000019	0.0001312	80.4	62	0.0070974	0.0063579	0.0075268	23.4
3	0.0000688	–	0.0001466	79.4	63	0.0078021	0.0068684	0.0081651	22.6
4	0.0000582	0.0000101	0.0001562	78.4	64	0.0086713	0.0076143	0.0090447	21.8
5	0.0000543	–	0.0001123	77.4	65	0.0095833	0.0089048	0.0105576	21.0
6	0.0000539	0.0000287	0.0001895	76.4	66	0.0105349	0.0096438	0.0114647	20.2
7	0.0000555	0.0000197	0.0001732	75.5	67	0.0114564	0.0110306	0.0130871	19.4
8	0.0000584	0.0000200	0.0001495	74.5	68	0.0124987	0.0107566	0.0128659	18.6
9	0.0000624	0.0000020	0.0001252	73.5	69	0.0135974	0.0120266	0.0143593	17.8
10	0.0000673	0.0000100	0.0001456	72.5	70	0.0150356	0.0131070	0.0156831	17.1
11	0.0000738	0.0000257	0.0001844	71.5	71	0.0166761	0.0151923	0.0181320	16.3
12	0.0000831	0.0000425	0.0002255	70.5	72	0.0187002	0.0162117	0.0193218	15.6
13	0.0000971	0.0000089	0.0001312	69.5	73	0.0208752	0.0197566	0.0233805	14.9
14	0.0001182	0.0000188	0.0001508	68.5	74	0.0232898	0.0204555	0.0242138	14.2
15	0.0001487	0.0000634	0.0002945	67.5	75	0.0257844	0.0237511	0.0279666	13.5
16	0.0001909	0.0000195	0.0001965	66.5	76	0.0286674	0.0263564	0.0310054	12.8
17	0.0002796	0.0001060	0.0003647	65.5	77	0.0317212	0.0279893	0.0330158	12.2
18	0.0003740	0.0001074	0.0003561	64.5	78	0.0348424	0.0314183	0.0370503	11.6

BR-EMSsb-V.2015-m									
Age x	q_x	-IC(95%)	+IC(95%)	e_x	Age x	q_x	-IC(95%)	+IC(95%)	e_x
19	0.0004909	0.0003343	0.0006625	63.6	79	0.0382344	0.0369938	0.0433616	11.0
20	0.0006045	0.0005644	0.0009935	62.6	80	0.0417852	0.0377950	0.0445176	10.4
21	0.0007069	0.0004186	0.0007494	61.6	81	0.0457989	0.0388412	0.0458777	9.8
22	0.0007623	0.0007485	0.0011770	60.7	82	0.0499480	0.0481660	0.0566452	9.3
23	0.0007817	0.0007073	0.0010812	59.7	83	0.0544018	0.0473654	0.0564657	8.7
24	0.0007731	0.0004720	0.0007466	58.8	84	0.0597001	0.0555617	0.0660344	8.2
25	0.0007544	0.0006772	0.0009975	57.8	85	0.0665090	0.0590970	0.0710866	7.7
26	0.0007373	0.0005705	0.0008389	56.9	86	0.0744187	0.0581873	0.0710348	7.2
27	0.0007298	0.0005357	0.0007748	55.9	87	0.0839599	0.0775002	0.0938849	6.8
28	0.0007258	0.0006692	0.0009324	54.9	88	0.0934390	0.0884822	0.1085387	6.3
29	0.0007177	0.0006331	0.0008741	54.0	89	0.1049700	0.0882675	0.1108556	5.9
30	0.0007211	0.0005669	0.0007785	53.0	90	0.1143591	0.1084554	0.1372477	5.6
31	0.0007342	0.0005625	0.0007703	52.0	91	0.1247292	0.0944340	0.1261158	5.2
32	0.0007579	0.0006251	0.0008474	51.1	92	0.1325577	0.1340578	0.1764087	4.9
33	0.0007941	0.0006910	0.0009280	50.1	93	0.1466181	0.1017761	0.1465084	4.6
34	0.0008395	0.0007406	0.0009804	49.2	94	0.1585720	0.1310846	0.1887968	4.3
35	0.0008802	0.0007860	0.0010373	48.2	95	0.1737468	0.1202828	0.1882540	4.0
36	0.0009202	0.0007437	0.0009856	47.2	96	0.1895589	0.1800968	0.2786733	3.7
37	0.0009512	0.0008456	0.0011122	46.3	97	0.2053710	0.1280817	0.2399470	3.4
38	0.0009876	0.0008457	0.0011124	45.3	98	0.2220684	0.1372591	0.2704877	3.2
39	0.0010291	0.0009099	0.0011870	44.4	99	0.2401233	0.0936042	0.2478258	3.0
40	0.0010883	0.0008832	0.0011552	43.4	100	0.2596462	0.0709706	0.2612205	2.8
41	0.0011563	0.0009721	0.0012590	42.5	101	0.2807563	–	–	2.6
42	0.0012443	0.0010892	0.0013957	41.5	102	0.3035828	–	–	2.4
43	0.0013505	0.0011953	0.0015121	40.6	103	0.3282651	–	–	2.2
44	0.0014798	0.0012633	0.0015954	39.6	104	0.3549543	–	–	2.0
45	0.0016034	0.0014090	0.0017597	38.7	105	0.3838133	–	–	1.9
46	0.0017246	0.0015799	0.0019457	37.7	106	0.4150187	–	–	1.7
47	0.0018463	0.0017713	0.0021654	36.8	107	0.4487611	–	–	1.6
48	0.0020009	0.0016472	0.0020233	35.9	108	0.4852470	–	–	1.4
49	0.0021789	0.0018339	0.0022444	34.9	109	0.5246993	–	–	1.3
50	0.0023873	0.0020945	0.0025436	34.0	110	0.5673592	–	–	1.2
51	0.0026229	0.0024889	0.0029863	33.1	111	0.6134875	–	–	1.1
52	0.0029034	0.0026636	0.0031939	32.2	112	0.6633662	–	–	1.0
53	0.0032172	0.0027495	0.0033021	31.3	113	0.7173002	–	–	0.9
54	0.0035536	0.0031244	0.0037195	30.4	114	0.7756192	–	–	0.8
55	0.0039070	0.0036191	0.0042868	29.5	115	0.8386798	–	–	0.7
56	0.0042981	0.0040578	0.0047995	28.6	116	0.9068674	–	–	0.6
57	0.0047163	0.0042631	0.0050350	27.7	117	0.9805989	–	–	0.5
58	0.0051323	0.0045029	0.0053273	26.9	118	1.0000000	–	–	0.5
59	0.0055507	0.0052183	0.0061402	26.0					

Source: Brazilian insurance companies participating in the analysis, CNIS, and SISOBI.

TABLE 2
BR-EMS 2015 mortality table for females, survivorship coverage

BR-EMSsb-V.2015-f									
Age x	q_x	-IC(95%)	+IC(95%)	e_x	Age x	q_x	-IC(95%)	+IC(95%)	e_x
0	0.0003438	–	0.0005157	87.8	60	0.0033009	0.0028676	0.0037850	29.5
1	0.0001527	0.0000024	0.0002489	86.8	61	0.0035957	0.0028336	0.0038094	28.6
2	0.0001159	0.0000291	0.0002981	85.8	62	0.0039135	0.0034820	0.0046102	27.7
3	0.0000791	–	0.0001047	84.8	63	0.0042898	0.0036846	0.0049342	26.8
4	0.0000576	0.0000272	0.0002201	83.9	64	0.0047135	0.0038296	0.0050806	25.9
5	0.0000494	0.0000895	0.0003281	82.9	65	0.0052346	0.0043106	0.0057349	25.0
6	0.0000471	0.0000358	0.0002272	81.9	66	0.0057864	0.0050778	0.0067244	24.1
7	0.0000475	0.0000894	0.0003290	80.9	67	0.0063930	0.0052629	0.0069876	23.3
8	0.0000496	0.0000050	0.0001481	79.9	68	0.0071061	0.0064645	0.0084680	22.4
9	0.0000526	0.0000120	0.0001408	78.9	69	0.0079214	0.0064644	0.0085299	21.6
10	0.0000565	–	0.0000802	77.9	70	0.0088362	0.0068243	0.0090208	20.7
11	0.0000610	0.0000110	0.0001439	76.9	71	0.0097454	0.0093127	0.0119991	19.9
12	0.0000664	0.0000383	0.0002216	75.9	72	0.0107480	0.0093361	0.0120629	19.1
13	0.0000731	–	0.0000975	74.9	73	0.0117749	0.0103784	0.0133390	18.3
14	0.0000825	–	0.0001456	73.9	74	0.0128002	0.0106514	0.0136876	17.5
15	0.0000968	0.0000122	0.0000707	72.9	75	0.0138450	0.0122032	0.0155904	16.7
16	0.0001220	0.0000261	0.0002453	71.9	76	0.0151097	0.0135731	0.0172523	16.0
17	0.0001428	0.0001054	0.0004234	70.9	77	0.0166446	0.0134669	0.0172280	15.2
18	0.0001708	0.0000563	0.0002825	69.9	78	0.0186115	0.0159908	0.0202627	14.5
19	0.0002035	0.0000661	0.0002514	68.9	79	0.0210603	0.0179160	0.0225324	13.7
20	0.0002313	0.0000925	0.0003476	68.0	80	0.0240473	0.0200704	0.0251228	13.0
21	0.0002520	0.0001684	0.0004502	67.0	81	0.0273368	0.0251988	0.0311254	12.3
22	0.0002726	0.0001497	0.0004179	66.0	82	0.0307907	0.0274535	0.0338054	11.6
23	0.0002870	0.0001298	0.0003398	65.0	83	0.0342908	0.0312612	0.0385392	11.0
24	0.0002872	0.0002469	0.0005221	64.0	84	0.0381713	0.0334486	0.0415755	10.4
25	0.0002883	0.0001412	0.0003350	63.0	85	0.0428888	0.0358394	0.0448472	9.8
26	0.0002895	0.0001775	0.0003840	62.1	86	0.0490175	0.0403966	0.0508624	9.2
27	0.0002978	0.0001950	0.0004009	61.1	87	0.0560458	0.0474815	0.0597653	8.6
28	0.0003144	0.0001755	0.0003548	60.1	88	0.0632215	0.0575942	0.0728071	8.1
29	0.0003336	0.0002579	0.0004578	59.1	89	0.0703395	0.0669034	0.0853944	7.6
30	0.0003480	0.0002617	0.0004560	58.1	90	0.0776935	0.0664111	0.0872479	7.2
31	0.0003575	0.0003326	0.0005385	57.2	91	0.0858280	0.0660068	0.0902789	6.7
32	0.0003685	0.0002281	0.0003944	56.2	92	0.0942675	0.0765699	0.1062159	6.3
33	0.0003831	0.0002264	0.0004000	55.2	93	0.1042955	0.0870142	0.1234421	5.9
34	0.0004103	0.0003342	0.0005410	54.2	94	0.1150503	0.0986205	0.1421199	5.5
35	0.0004548	0.0002982	0.0004957	53.2	95	0.1264029	0.0941398	0.1442040	5.2
36	0.0004992	0.0004159	0.0006577	52.3	96	0.1371851	0.1101155	0.1738843	4.9
37	0.0005337	0.0004523	0.0007060	51.3	97	0.1477910	0.1075871	0.1854425	4.6
38	0.0005578	0.0004796	0.0007449	50.3	98	0.1592878	0.1059616	0.2071148	4.3
39	0.0005769	0.0004119	0.0006616	49.3	99	0.1717446	0.1126357	0.2387093	4.0
40	0.0005968	0.0003913	0.0006388	48.4	100	0.1817103	0.0899087	0.2533851	3.7
41	0.0006254	0.0005375	0.0008252	47.4	101	0.1981795	–	–	3.4
42	0.0006793	0.0004663	0.0007397	46.4	102	0.2190084	–	–	3.1
43	0.0007460	0.0005906	0.0008950	45.5	103	0.2420264	–	–	2.8

BR-EMSsb-V.2015-f									
Age *x*	q_x	-IC(95%)	+IC(95%)	e_x	Age *x*	q_x	-IC(95%)	+IC(95%)	e_x
44	0.0008159	0.0006497	0.0009733	44.5	104	0.2674637	–	–	2.6
45	0.0008868	0.0007489	0.0010885	43.5	105	0.2955744	–	–	2.4
46	0.0009663	0.0008232	0.0011819	42.6	106	0.3266396	–	–	2.1
47	0.0010661	0.0007522	0.0011014	41.6	107	0.3609698	–	–	1.9
48	0.0011670	0.0009623	0.0013619	40.7	108	0.3989082	–	–	1.7
49	0.0012926	0.0010524	0.0014679	39.7	109	0.4408339	–	–	1.6
50	0.0014107	0.0013033	0.0017936	38.8	110	0.4871661	–	–	1.4
51	0.0015282	0.0011978	0.0016772	37.8	111	0.5383679	–	–	1.2
52	0.0016306	0.0014741	0.0020170	36.9	112	0.5949510	–	–	1.1
53	0.0017601	0.0014116	0.0019488	35.9	113	0.6574810	–	–	1.0
54	0.0019246	0.0014128	0.0019588	35.0	114	0.7265831	–	–	0.8
55	0.0021113	0.0018153	0.0024670	34.0	115	0.8029478	–	–	0.7
56	0.0023298	0.0020125	0.0027104	33.1	116	0.8873386	–	–	0.6
57	0.0025640	0.0023128	0.0030794	32.2	117	0.9805989	–	–	0.5
58	0.0028004	0.0022189	0.0029948	31.3	118	1.0000000	–	–	0.5
59	0.0030334	0.0026527	0.0035199	30.4					

Source: Brazilian insurance companies participating in the analysis, CNIS, and SISOBI.

TABLE 3
BR-EMS 2015 mortality table for males, death coverage

BR-EMSmt-V.2015-m									
Age *x*	q_x	-IC(95%)	+IC(95%)	e_x	Age *x*	q_x	-IC(95%)	+IC(95%)	e_x
0	0.0003911	–	–	79.9	60	0.0084372	0.0083931	0.0091053	23.7
1	0.0002025	–	–	78.9	61	0.0092120	0.0087556	0.0095160	22.9
2	0.0001350	–	–	77.9	62	0.0098629	0.0093399	0.0101625	22.1
3	0.0001068	–	–	77.0	63	0.0106900	0.0102532	0.0111506	21.3
4	0.0000948	–	–	76.0	64	0.0116459	0.0111312	0.0121026	20.5
5	0.0000906	–	–	75.0	65	0.0125490	0.0120788	0.0131592	19.8
6	0.0000909	–	–	74.0	66	0.0135129	0.0128054	0.0140171	19.0
7	0.0000938	–	–	73.0	67	0.0143795	0.0138099	0.0152074	18.3
8	0.0000987	–	–	72.0	68	0.0156326	0.0144610	0.0159763	17.5
9	0.0001052	–	–	71.0	69	0.0167943	0.0163247	0.0180164	16.8
10	0.0001141	–	–	70.0	70	0.0183789	0.0170886	0.0188987	16.1
11	0.0001277	–	–	69.0	71	0.0202899	0.0189700	0.0209750	15.4
12	0.0001509	–	–	68.0	72	0.0226976	0.0217824	0.0240245	14.7
13	0.0001911	–	–	67.0	73	0.0254119	0.0239913	0.0264423	14.0
14	0.0002557	–	–	66.0	74	0.0280659	0.0267492	0.0294820	13.4
15	0.0003486	0.0001388	0.0009397	65.1	75	0.0298929	0.0293750	0.0323556	12.7
16	0.0004682	0.0002126	0.0005339	64.1	76	0.0326954	0.0292065	0.0321888	12.1
17	0.0006352	0.0004362	0.0007509	63.1	77	0.0358784	0.0347630	0.0382833	11.5
18	0.0008963	0.0008160	0.0010616	62.2	78	0.0398857	0.0384142	0.0424148	10.9
19	0.0010702	0.0010604	0.0012523	61.2	79	0.0429656	0.0405713	0.0448674	10.4
20	0.0011606	0.0010260	0.0012046	60.3	80	0.0479174	0.0434413	0.0480848	9.8
21	0.0011614	0.0011275	0.0012927	59.3	81	0.0528419	0.0525664	0.0579730	9.3
22	0.0011614	0.0010799	0.0012380	58.4	82	0.0586542	0.0545016	0.0604839	8.8

BR-EMSmt-V.2015-m									
Age *x*	q_x	-IC(95%)	+IC(95%)	e_x	Age *x*	q_x	-IC(95%)	+IC(95%)	e_x
23	0.0011071	0.0010397	0.0011907	57.5	83	0.0638227	0.0597814	0.0666190	8.3
24	0.0010760	0.0009748	0.0011196	56.5	84	0.0694993	0.0668961	0.0746545	7.8
25	0.0010557	0.0009928	0.0011384	55.6	85	0.0773917	0.0702550	0.0787896	7.3
26	0.0010491	0.0009836	0.0011249	54.7	86	0.0847935	0.0818401	0.0919153	6.9
27	0.0010373	0.0009565	0.0010986	53.7	87	0.0943216	0.0872256	0.0987353	6.5
28	0.0010233	0.0009600	0.0011002	52.8	88	0.1019140	0.0963876	0.1098260	6.1
29	0.0010371	0.0009443	0.0010800	51.8	89	0.1130950	0.1019021	0.1174076	5.8
30	0.0010541	0.0009982	0.0011398	50.9	90	0.1207108	0.1171713	0.1358756	5.5
31	0.0010763	0.0010094	0.0011531	49.9	91	0.1284853	0.1152730	0.1366352	5.1
32	0.0011029	0.0010056	0.0011518	49.0	92	0.1389316	0.1199890	0.1459676	4.8
33	0.0011428	0.0010704	0.0012272	48.0	93	0.1502272	0.1399481	0.1728321	4.5
34	0.0011748	0.0011209	0.0012810	47.1	94	0.1624412	0.1568366	0.1990034	4.2
35	0.0012103	0.0010941	0.0012551	46.1	95	0.1756482	0.1542759	0.2043695	4.0
36	0.0012596	0.0011690	0.0013415	45.2	96	0.1899291	0.1410388	0.1983652	3.7
37	0.0013443	0.0012596	0.0014381	44.3	97	0.2053710	0.1422694	0.2136175	3.4
38	0.0014038	0.0013341	0.0015235	43.3	98	0.2220684	–	–	3.2
39	0.0014580	0.0013409	0.0015266	42.4	99	0.2401233	–	–	3.0
40	0.0015362	0.0014131	0.0016096	41.4	100	0.2596462	–	–	2.8
41	0.0016430	0.0015595	0.0017676	40.5	101	0.2807563	–	–	2.6
42	0.0017815	0.0016467	0.0018615	39.6	102	0.3035828	–	–	2.4
43	0.0018980	0.0018131	0.0020408	38.6	103	0.3282651	–	–	2.2
44	0.0020322	0.0018962	0.0021294	37.7	104	0.3549543	–	–	2.0
45	0.0021748	0.0020363	0.0022776	36.8	105	0.3838133	–	–	1.9
46	0.0023466	0.0022256	0.0024840	35.9	106	0.4150187	–	–	1.7
47	0.0025429	0.0023953	0.0026606	34.9	107	0.4487611	–	–	1.6
48	0.0027966	0.0026062	0.0028858	34.0	108	0.4852470	–	–	1.4
49	0.0030327	0.0029606	0.0032710	33.1	109	0.5246993	–	–	1.3
50	0.0033904	0.0030737	0.0033992	32.2	110	0.5673592	–	–	1.2
51	0.0037727	0.0036405	0.0039977	31.3	111	0.6134875	–	–	1.1
52	0.0042051	0.0040662	0.0044589	30.5	112	0.6633662	–	–	1.0
53	0.0046575	0.0043296	0.0047377	29.6	113	0.7173002	–	–	0.9
54	0.0050194	0.0049536	0.0053993	28.7	114	0.7756192	–	–	0.8
55	0.0055152	0.0051148	0.0055818	27.9	115	0.8386798	–	–	0.7
56	0.0059796	0.0057641	0.0062775	27.0	116	0.9068674	–	–	0.6
57	0.0065447	0.0062955	0.0068442	26.2	117	0.9805989	–	–	0.5
58	0.0070133	0.0067519	0.0073352	25.3	118	1.0000000	–	–	0.5
59	0.0077397	0.0071131	0.0077400	24.5					

Source: Brazilian insurance companies participating in the analysis, CNIS, and SISOBI.

TABLE 4
BR-EMS 2015 mortality table for females, death coverage

BR-EMSmt-V.2015-f									
Age x	q_x	-IC(95%)	+IC(95%)	e_x	Age x	q_x	-IC(95%)	+IC(95%)	e_x
0	0.0004151	–	–	84.7	60	0.0052625	0.0047657	0.0053806	27.1
1	0.0001843	–	–	83.7	61	0.0057335	0.0053405	0.0060323	26.2
2	0.0001048	–	–	82.7	62	0.0062466	0.0058562	0.0066011	25.3
3	0.0000732	–	–	81.7	63	0.0067445	0.0065460	0.0073847	24.5
4	0.0000600	–	–	80.7	64	0.0072829	0.0066739	0.0075465	23.7
5	0.0000551	–	–	79.8	65	0.0078072	0.0073839	0.0083633	22.8
6	0.0000543	–	–	78.8	66	0.0084053	0.0075111	0.0086130	22.0
7	0.0000558	–	–	77.8	67	0.0090414	0.0084463	0.0098087	21.2
8	0.0000588	–	–	76.8	68	0.0097934	0.0088182	0.0102934	20.4
9	0.0000627	–	–	75.8	69	0.0105983	0.0097606	0.0114250	19.6
10	0.0000675	–	–	74.8	70	0.0115216	0.0104040	0.0122794	18.8
11	0.0000730	–	–	73.8	71	0.0124819	0.0113474	0.0134358	18.0
12	0.0000791	–	–	72.8	72	0.0136001	0.0122920	0.0145151	17.2
13	0.0000862	–	–	71.8	73	0.0147735	0.0135792	0.0160197	16.4
14	0.0000950	–	–	70.8	74	0.0164225	0.0141698	0.0167845	15.7
15	0.0001080	–	–	69.8	75	0.0182079	0.0164700	0.0195039	14.9
16	0.0001299	0.0000675	0.0002320	68.8	76	0.0203084	0.0168877	0.0200380	14.2
17	0.0001653	0.0001299	0.0002993	67.8	77	0.0223018	0.0233764	0.0274675	13.5
18	0.0002244	0.0002146	0.0003829	66.8	78	0.0247974	0.0214198	0.0255632	12.8
19	0.0002806	0.0002227	0.0003381	65.8	79	0.0276023	0.0239309	0.0286157	12.1
20	0.0003307	0.0002825	0.0004181	64.9	80	0.0309387	0.0258966	0.0309048	11.4
21	0.0003653	0.0003856	0.0005257	63.9	81	0.0348520	0.0317041	0.0376682	10.8
22	0.0003893	0.0003599	0.0004934	62.9	82	0.0394659	0.0374427	0.0442739	10.1
23	0.0004000	0.0003049	0.0004248	61.9	83	0.0444953	0.0380712	0.0456849	9.5
24	0.0003980	0.0003116	0.0004353	61.0	84	0.0497225	0.0465859	0.0557147	9.0
25	0.0003921	0.0003841	0.0005170	60.0	85	0.0559396	0.0491658	0.0595253	8.4
26	0.0003997	0.0002859	0.0003979	59.0	86	0.0627591	0.0534150	0.0651957	7.9
27	0.0004128	0.0003466	0.0004746	58.0	87	0.0699435	0.0616295	0.0757743	7.4
28	0.0004337	0.0003476	0.0004643	57.1	88	0.0770216	0.0736720	0.0916715	6.9
29	0.0004563	0.0003993	0.0005269	56.1	89	0.0854361	0.0744645	0.0951460	6.4
30	0.0004818	0.0004485	0.0005844	55.1	90	0.0952068	0.0757165	0.0996102	6.0
31	0.0005078	0.0004330	0.0005648	54.1	91	0.1055215	0.0839596	0.1130493	5.5
32	0.0005376	0.0004572	0.0005977	53.2	92	0.1176157	0.1033095	0.1414962	5.1
33	0.0005755	0.0004453	0.0005818	52.2	93	0.1322245	0.1125635	0.1601010	4.7
34	0.0006176	0.0005518	0.0007060	51.2	94	0.1462507	0.1044274	0.1598997	4.4
35	0.0006637	0.0006072	0.0007749	50.2	95	0.1626539	0.1297183	0.2063967	4.1
36	0.0007043	0.0006385	0.0008132	49.3	96	0.1810076	0.1409713	0.2387968	3.8
37	0.0007494	0.0006711	0.0008449	48.3	97	0.1999287	0.1110581	0.2109873	3.5
38	0.0007991	0.0006570	0.0008384	47.4	98	0.2191843	0.1725731	0.3321869	3.2
39	0.0008630	0.0006815	0.0008643	46.4	99	0.2407379	–	–	3.0
40	0.0009412	0.0008834	0.0010969	45.4	100	0.2596462	–	–	2.8
41	0.0010410	0.0009221	0.0011333	44.5	101	0.2807563	–	–	2.6
42	0.0011431	0.0010048	0.0012262	43.5	102	0.3035828	–	–	2.4
43	0.0012474	0.0011412	0.0013809	42.6	103	0.3282651	–	–	2.2

BR-EMSmt-V.2015-f									
Age *x*	q_x	-IC(95%)	+IC(95%)	e_x	Age *x*	q_x	-IC(95%)	+IC(95%)	e_x
44	0.0013457	0.0012707	0.0015282	41.6	104	0.3549543	–	–	2.0
45	0.0014550	0.0012545	0.0015078	40.7	105	0.3838133	–	–	1.9
46	0.0015758	0.0014424	0.0017069	39.7	106	0.4150187	–	–	1.7
47	0.0017322	0.0015149	0.0017893	38.8	107	0.4487611	–	–	1.6
48	0.0019093	0.0016752	0.0019606	37.9	108	0.4852470	–	–	1.4
49	0.0021023	0.0019559	0.0022796	36.9	109	0.5246993	–	–	1.3
50	0.0022899	0.0022768	0.0026269	36.0	110	0.5673592	–	–	1.2
51	0.0024860	0.0022645	0.0026194	35.1	111	0.6134875	–	–	1.1
52	0.0026688	0.0024223	0.0027966	34.2	112	0.6633662	–	–	1.0
53	0.0028667	0.0026119	0.0030014	33.3	113	0.7173002	–	–	0.9
54	0.0030948	0.0029047	0.0033214	32.4	114	0.7756192	–	–	0.8
55	0.0033761	0.0029982	0.0034239	31.5	115	0.8386798	–	–	0.7
56	0.0036901	0.0034205	0.0038902	30.6	116	0.9068674	–	–	0.6
57	0.0040317	0.0038030	0.0043143	29.7	117	0.9805989	–	–	0.5
58	0.0044048	0.0040906	0.0046365	28.8	118	1.0000000	–	–	0.5
59	0.0048090	0.0045244	0.0051096	27.9					

Source: Brazilian insurance companies participating in the analysis, CNIS, and SISOBI.

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