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FREE THEME ARTICLE

Distribution of garbage codes in the Mortality Information System, Brazil, 2000 to 2020

Distribuição dos códigos garbage no Sistema de Informações sobre Mortalidade, Brasil, 2000 a 2020

Distribución de códigos de basura en el Sistema de Información sobre Mortalidad, Brasil, 2000 a 2020

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Abstract *The analysis of the causes of death is essential to understand the main problems that affect the health level of the population of a region or country. The garbage codes (GC) provide little useful information about causes of death. This study aims to identify the proportion of GC among the deaths registered and to analyze their temporal distribution in Brazil from 2000 to 2020. It's an ecological time-series study of the evolution of the proportion of GC in Brazil. Time series analysis was performed using segmented linear regression models (joinpoint). Between 2000 and 2020, 39.9% of deaths that occurred in Brazil were coded with GC. Between 2000 and 2007, there was a continuous and persistent reduction in the proportion of GC (APC -2.1; P < 0.001). Between 2007 and 2015, there continued to be a reduction, albeit to a lesser extent (APC = -0.7; P = 0.013). Between 2015 and 2018, there was no significant trend of the proportion of GC (APC = -2.3; P = 0.172), which persisted from 2018 (APC 3.2; P < 0.079). Although a reduction in the proportion of GC in Brazil was observed until 2018, this trend did not persist after that year. Reducing the proportion of GC allows managers to plan health policies more adequately for the population.*
Key words *Vital statistics, Cause of death, Data accuracy, Information systems*

Resumo *A análise das causas de morte é essencial para compreender os principais problemas que afetam o nível de saúde da população de uma região ou país. Os garbage codes (GC) fornecem poucas informações úteis sobre as causas de morte. Este estudo tem como objetivo identificar a proporção de CG entre os óbitos registrados e analisar sua distribuição temporal no Brasil de 2000 a 2020. Trata-se de um estudo ecológico de séries temporais da evolução da proporção da CG no Brasil. A análise de séries temporais foi realizada por meio de modelos de regressão linear segmentada (joinpoint). Entre 2000 e 2020, 39,9% dos óbitos ocorridos no Brasil foram codificados com CG. Entre 2000 e 2007, houve redução contínua e persistente na proporção de CG (APC -2,1; P < 0,001). Entre 2007 e 2015, manteve-se a redução, embora em menor escala (APC = -0,7; P = 0,013). Entre 2015 e 2018, não houve tendência significativa da proporção de GC (APC = -2,3; P = 0,172), que persistiu a partir de 2018 (APC 3,2; P < 0,079). Embora tenha sido observada redução na proporção de GC no Brasil até 2018, essa tendência não persistiu após esse ano. A redução da proporção de CG permite aos gestores planejar políticas de saúde de forma mais adequada para a população.*
Palavras-chave *Estatísticas vitais, Causa da morte, Precisão de dados, Sistemas de informação*

Resumen *El análisis de las causas de muerte es fundamental para comprender los principales problemas que afectan el nivel de salud de la población de una región o país. Los códigos de basura (CB) proporcionan poca información útil sobre las causas de muerte. Este estudio tiene como objetivo identificar la proporción de CB entre las muertes registradas y analizar su distribución temporal en Brasil de 2000 a 2020. Se trata de un estudio de series temporales ecológicas de la evolución de la proporción de CB en Brasil. El análisis de series temporales se realizó mediante modelos de regresión lineal segmentados (joinpoint). Entre 2000 y 2020, el 39,9% de las muertes ocurridas en Brasil fueron codificadas con CB. Entre 2000 y 2007, hubo una reducción continua y persistente en la proporción de CB (APC -2,1; P <0,001). Entre 2007 y 2015, la reducción continuó, aunque en menor escala (APC = -0,7; P = 0,013). Entre 2015 y 2018, no hubo una tendencia significativa en la proporción de CB (APC = -2,3; P = 0,172), que persistió a partir de 2018 (APC 3,2; P <0,079). Aunque se observó una reducción en la proporción de CB en Brasil hasta 2018, esta tendencia no persistió después de ese año. Reducir la proporción de CB permite a los gestores planificar políticas de salud de manera más adecuada para la población.*
Palabras clave *Estadísticas vitales, Causa de muerte, Precisión de los datos, Sistemas de información*

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Introduction

The analysis of the causes of death is essential to understand the main problems that affect the health level of the population of a region or country. The estimation of mortality rates allows measuring the risk of death that different population groups are exposed to, besides trends over time and possible inequalities between groups, generations or locations[1]. Such rates can also subsidize the formulation, planning and evaluation of social, economic and health interventions, public policies and health services aimed at a specific population[2,3].

In Brazil, data on deaths are stored and monitored by the Mortality Information System (SIM). Created in 1975, this system is currently a fundamental tool for health surveillance in the country[1].

In the Instructions for Completing the Death Certificate (SIM base document)[4], the underlying cause of death is defined as "the illness or injury that initiated the chain of pathological events directly leading to death or the circumstances of the accident or violence that produced the fatal injury".

According to Oliveira e Souza (2007)[5], when the death certificate is correctly filled in, the underlying cause field helps to establish information of great epidemiological importance for identifying the causes of death affecting a given population. It thus allows really identifying situations of vulnerability and guide interventions aimed at these causes of death[6]. Despite its relevance, failures may occur in filling out this field[7].

Completing the death certificate is the doctor's responsibility. Failures to fill in the underlying cause of death may occur due to the doctors' lack of knowledge regarding the International Classification of Diseases and Related Health Problems (ICD) and the practice of correct procedures for completing the Death Certificate or even due to lack of information about the sequence of events leading to death. Furthermore, the doctor may not be able to correctly identify the cause of death due to the lack of access to timely complementary exams or the short period between the patient's admission to the health care system and death, a very common case in hospital emergencies. In both cases it is difficult to reconstruct the sequence of events that led to death. Another challenge is natural deaths at home in cases where the person did not receive frequent medical care and in municipalities where there is no death verification service. Additionally, errors can also occur during the process of coding the underlying cause of death[8-10].

Consequently, Death Certificate sometimes present incorrect cause of death or use unspecific or intermediate causes (e.g. heart failure, septicemia), ill-defined conditions or symptoms (e.g. dyspnea), or unspecified codes within larger groups of patients (for example: uterine cancer in an unspecified portion in the group of neoplasms)[7].

The term garbage code (GC) was introduced by Murray and Lopez in 1996 as part of the framework Global Burden of Disease (GBD)[11] to describe those codes that provide little useful information to identify and plan public health actions[2]. A high proportion of GC compromises the quality of information on causes of death, hindering the identification of priorities and plan actions[1,6]. Therefore, analyzing the proportion of GC helps to assess the limitations related to the quality of data on mortality[13,14].

SIM data have evolved since 2005 with a reduction in underreporting ill-defined causes and the proportion of GC[15]. However, during the pandemic, with excess mortality from Corona virus 19 disease (COVID-19), an increase in the proportion of GC[16] was reported, making it is important to monitor its evolution.

Due to the importance of this group of causes in the analysis of mortality data, this study aims to identify the proportion of GC among the deaths registered in the SIM and to analyze their temporal distribution in Brazil during the last decade, specifically for the period from 2000 to 2020, according to sociodemographic characteristics and GC level.

Methods

This research is a time-series study of the GC proportion evolution for deaths recorded in the Mortality Information System in Brazil from 2000 to 2020.

The data plan for this article can be consulted at: https://doi.org/10.48321/D15W40[17].

GC selection was based on the GBD 2017 list[8,18]. However, code B34.2 (coronavirus infection of unspecified location) was excluded from the list for analysis, because this code in Brazil was recommended for deaths caused by COVID-19[19].

Descriptive analyses were performed as used to characterize the victims of deaths coded as GC. For time series analyses, the proportion of GC was calculated using the number of

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deaths whose underlying cause was coded with such codes as the numerator and considering the total number of deaths in the same period and population as the denominator. The analyses were performed not only for the total GC but also for the sex, age group, race/color, and region of residence of the victims and the level of severity, considering their impact on public policies.

The four levels of GC severity, described by the GBD study, were considered[18,20]: (i) very high (level 1), for causes with serious implications; (ii) high (level 2), for CG with substantial implications; (iii) medium (level 3), containing CG with important implications; and (iv) low (level 4), in which GC has limited implications. According to GBD, levels 1 and 2 are the most important due to their greater impact on mortality analyses[18].

When processing the list, for underlying causes defined as GC and identified with three-character codes, all implied four-character underlying causes were included. For example, code D68 (other coagulation defects), included in the list, considered deaths whose underlying cause was described with codes D68.0 to D68.9. The codes already present in the four-digit list at the time of treatment, were maintained exactly as described.

The Joinpoint software (Statistical Research and Applications Branch) was used to analyze trends. Joinpoint was developed by the National Cancer Institute (USA) to analyze data from the Surveillance Epidemiology Program[21]. Therefore, time series analysis was performed using segmented linear regression models (join point), in which trend analyses are performed by testing whether inflection points are statistically significant and should be added to the model[22]. The software provides several tests to select the number of join points that generate the model that best represents each data series, using the Bonferroni correction for multiple tests. Permutation tests are performed to select the number of join points. The program uses a Monte Carlo sample of the dataset extracted from of all possible permutations using a random number generator[21]. This allows testing whether an apparent change in trend is statistically significant. Summarizing, using the GC ratio as input, this method identifies the year(s) in which a change in trend occurs, calculates the Annual Percentage Change (APC) in rates between trend change points, and estimates the Average Annual Percentage Change (AAPC) throughout the period studied[21]. The APC calculation was performed for the line segments. As multiple tests are performed, the significance level of each test is adjusted to control the Type I overall error for a specified level (0.05). Thus, trends were considered significant if they presented $P < 0.05$ and with confidence interval of 95% (95%CI) that did not include the zero-value obtained by the geometric mean of the APC, with equal weights for each length at each defined time interval[23]. The year of occurrence was considered as an independent variable of the events. The proportions of GC in the defined disaggregation were considered as dependent variables.

There was no need for submission to the Research Ethics Committee, since this study uses secondary data in the public domain, without identifying the participants. Resolution 466 of the National Health Council of December 12, 2012 is complied with[24].

Results

Between 2000 and 2020, 9,738,958 deaths were coded as GC in Brazil, corresponding to 39.9% of all deaths that occurred in the country in that period. Table 1 presents the distribution of the number and proportion of these deaths according to the victims' demographic characteristics. Due to limited space, the data presented refer only to the years 2000, 2005, 2010, 2015 and 2020. However, data for the entire period studied can be accessed at: https://repositorio.uspdigital.usp.br/handle/item/477. Table 2 presents the distribution of GC rates (number of deaths / population) in the same period.

Considering only the deaths with defined characteristics of the victim, the female gender presented the highest proportions of GC throughout the period studied, ranging from 50.9%, in 2000, to 41.0%, in 2020. The age range with the highest magnitude of this indicator was 80 years and over, ranging from 55.6% in 2000 to 51.5% in 2020. As for race/color, there was an erratic behavior of the indicator: the highest values occurred among indigenous people in 2000 and 2010 (53.0% and 43.2%, respectively). In 2005 and 2015, the highest proportions of GC were observed among blacks (44.3% and 39.6%) and, in 2020, in the yellow race/color (40.4%). The Northeast Region had the highest indicator values throughout the period analyzed (from 57.9% in 2000 to 41.6% in 2020). The reduction in the number of deaths with "ignored" victim characteristics fields until 2015 in all variables studied is noteworthy.

Table 1. Distribution of GC according to sociodemographic characteristics, Brazil (2000, 2005, 2010, 2015 and 2020)

Characteristics	2000		2005		2010		2015		2020	
	n	%	n	%	n	%	n	%	n	%
Gender										
Female	200,141	50.9	199,853	47.1	216,102	44.4	235,612	42.5	242,536	41.0
Male	242,450	43.9	229,737	39.5	241,427	37.2	255,400	36.0	278,909	37.1
Ignored gender	415	43.6	180	39.8	164	38.0	297	44.0	275	44.6
Age group										
<1 year old	19,202	28.2	10,607	20.6	6,298	15.8	5,274	14.1	3,687	11.8
1 to 9 years old	7,878	47.4	5,571	41.3	4,265	38.2	3,205	36.2	2,240	32.5
10 to 19 years old	8,772	34.3	6,542	26.4	5,915	24.0	5,660	21.6	4,622	23.1
20 to 39 years old	40,951	36.0	31,849	28.6	29,891	25.2	28,374	23.9	29,320	25.9
40 to 59 years old	82,640	42.1	78,817	37.2	80,723	34.3	79,154	32.5	86,084	34.4
60 to 79 years old	167,219	49.5	165,149	45.3	174,462	42.4	186,534	40.1	204,674	39.6
80 years old and over	113,917	61.9	129,475	57.4	154,287	52.8	181,496	50.3	189,877	47.1
Ignored age group	2,427	55.6	1,760	50.6	1,852	46.7	1,612	49.2	1,216	51.5
Race/color										
White	216,293	43.4	221,868	40.6	235,143	39.3	244,569	38.0	247,098	37.4
Black	140,533	49.4	162,313	44.3	186,342	40.8	218,565	39.6	256,194	40.3
Indigenous	1,211	53.0	999	42.5	1,265	43.2	1,429	39.3	1,731	39.4
Yellow	4,517	43.6	2,552	44.2	2,477	40.2	2,685	38.1	3,241	40.4
Ignored race/color	80,452	53.4	42,038	49.0	32,466	44.5	24,061	42.3	13,456	39.5
Region of residence										
North	24,321	51.2	25,632	46.8	27,349	41.9	29,638	38.1	36,106	40.4
Northeast	131,709	57.9	125,677	49.5	122,597	43.2	143,479	42.6	150,096	41.6
Southeast	204,929	44.7	197,915	41.9	217,435	40.9	225920	39.5	250,685	41.4
South	57,197	37.6	56,302	35.2	63,223	35.3	63814	33.4	58,282	29.4
Midwest	21,593	39.9	22,122	35.9	25,291	34.7	26765	32.2	26,551	29.6
Ignored region	3,257	53.4	2,122	49.0	1,798	44.5	1693	42.3	-	0.0
Brazil	443,006	46.8	429,770	42.7	457,693	40.3	491309	38.9	521,720	38.8

Source: Authors.

Figure 1 shows the evolution of the predicted and observed values of the proportion of GC in Brazil, between 2000 and 2020. In that period, the AAPC for this indicator was -1.0 (95%CI = [-1.6, -0.4]; P < 0.001). However, the observed trend varied within this period and the analysis revealed three join points, configuring four segments with different trends. Between 2000 and 2007, there was a continuous and persistent reduction in the proportion of GC, with an APC of -2.1 (95%CI = [-2.5, -1.6]; P < 0.001). Between 2007 and 2015, there continued to be a reduction, albeit to a lesser extent (APC = -0.7; 95%CI = [-1.1, -0.2]; P = 0.013). Between 2015 and 2018, there was no significant trend of the proportion of GC (APC = -2.3; 95%CI = [-5.8, 1.2]; P = 0.172), which persisted from 2018, with APC of 3.2 (95%CI = [-0.4, 7.0]; P < 0.079).

Table 3 shows the tendency of the proportion of GC, according to the sociodemographic characteristics of the victims in Brazil between 2000 and 2020. Figures related to this analysis can be consulted at: https://repositorio.uspdigital.usp.br/handle/item/477. A downward trend in the GC proportion was observed in all breakdowns when considering the total period (2000 to 2020), except for ignored age and gender groups, in which there was stability. For most disaggregations, a reduction in the proportion of GC was observed in the initial periods of the series, although this decrease was uneven between the analyzed categories. In the age groups up to 10 years old, the reduction was continuous throughout the period, as well as for yellow race/color and in the South and Midwest regions. For both genders, in addition to the age groups from 60 years and the white and ignored race/color, a change in trend was observed, with stabilization as from 2015. For the age groups from 20 to 59 years, for the group of indigenous peoples and in the Southeast Region, there was a change in 2018, with an upward trend from then on. For

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Table 2. Distribution of the standardized* and gross death rate with underlying cause coded with garbage codes, according to the demographic characteristics of the victims, Brazil (2000, 2005, 2010, 2015 and 2020).

	2000		2005		2010		2015		2020	
	Gross rate	Standardized* rate	Gross rate	Standardized* rate	Gross rate	Standardized* rate	Gross rate	Standardized* rate	Gross rate	Standardized* rate
Gender										
Female	226.8	277.7	212.3	220.6	217.5	194.7	226.8	178.7	224.1	155.2
Male	283.5	385.8	252.9	312.9	252.8	279.4	256.5	256.7	269.4	239.9
Age group										
< 1 year old	142.1	---	90.9	---	61.6	---	50	---	35.3	---
1 to 9 years old	12.7	---	9.7	---	8.9	---	7	---	5.0	---
10 to 19 years old	24.3	---	18.6	---	17.1	---	17	---	14.9	---
20 to 39 years old	74.7	---	53.8	---	47.1	---	42	---	42.9	---
40 to 59 years old	283.7	---	225.6	---	198.3	---	173	---	170.4	---
60 to 79 years old	1,435.1	---	1,284.6	---	1,164.7	---	1,046	---	943.3	---
80 years old and over	7,541.1	---	5,798.6	---	5,185.8	---	5,048	---	4,275.5	---
Region of residence										
North	183.6	304.7	173.6	280.7	168.6	244.7	169.9	231.8	193.4	238.0
Northeast	269.4	326.3	242.9	277.0	226.8	231.3	257.8	244.0	261.6	222.9
Southeast	280.9	356.8	255.0	268.4	266.1	243.6	265.0	213.2	281.6	200.8
South	223.5	302.3	209.5	228.0	226.9	211.3	219.7	175.5	193.0	133.7
Midwest	168.3	237.7	176.6	215.9	173.7	187.8	160.9	151.3	160.9	151.3
Brazil	254.9	328.8	232.3	263.5	234.8	233.9	241.5	214.6	246.4	194.0

* Age-standardized mortality rate using direct method of standardization.

Source: Authors.

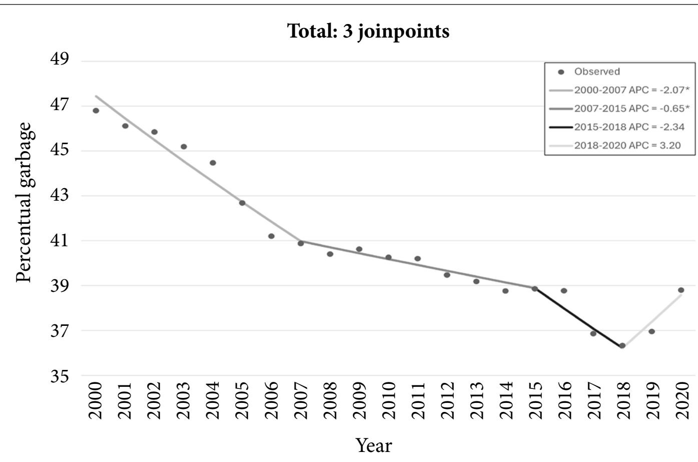

Figure 1. Trend in the proportion of GC, Brazil (2000 to 2020).

* Indicates that Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.

Source: Authors.

the black race/color and in the North Region, there was also a change in trend in 2018, which resulted in stability in the proportion of GC. The other disaggregations showed variable behavior of the indicator.

Figure 2 shows the trend in the proportion of GC according to their level, in Brazil, from 2000 to 2020. It was observed that the highest proportions were of level 1 GC throughout the analyzed period.

Table 3. Trend in the proportion of GC, according sociodemographic characteristics, Brazil (2000 to 2020).

Characteristics	AAPC (95%CI) 2000 - 2020	Trend 1		Trend 2		Trend 3		Trend 4	
		Years	APC (95%CI)	Years	APC (95%CI)	Years	APC (95%CI)	Years	APC (95%CI)
Gender									
Female	-1.2 (-1.8, -0.6)*	**2000-2007**	-1.9 (-2.3, -1.4)*	**2007-2015**	-0.8 (-1.3, -0.3)*	**2015-2018**	-2.8 (-6.3, 0.8)	**2018-2020**	2.1 (-1.5, 6.0)
Male	-0.9 (-1.5, -0.3)*	**2000-2007**	-2.3 (-2.8, -1.8)*	**2007-2015**	-0.6 (-1.1, -0.1)*	**2015-2018**	-2.0 (-5.5, 1.7)	**2018-2020**	4.2 (0.5, 8.1)*
Ignored gender	0.2 (-0.4, 0.9)	**2000-2020**	0.2 (-0.4, 0.9)	----	----	----	----	----	----
Age group									
<1 year old	-4.1 (-4.5, -3.6)*	**2000-2007**	-6.1 (-7.3, -5.0)*	**2007-2020**	-2.9 (-3.4, -2.5)*	----	----	----	----
1 to 9 years old	-1.5 (-1.9, -1.1)*	**2000-2007**	-2.6 (-3.7, -1.5)*	**2007-2020**	-0.9 (-1.3, -0.5)*	----	----	----	----
10 to 19 years old	-1.7 (-2.7, -0.8)*	**2000-2005**	-5.3 (-7.5,-3.1)*	**2005-2017**	-2.0 (-2.7, -1.3)*	**2017-2020**	5.5 (0.1, 11.1)*	----	----
20 to 39 years old	-1.4 (-2.1, -0.8)*	**2000-2006**	-4.6 (-5.6, -3.5)*	**2006-2018**	-1.5 (-1.9, -1.0)*	**2018-2020**	8.6 (1.8, 15.9)*	----	----
40 to 59 years old	-1.1 (-1.5, -0.7)*	**2000-2006**	-2.8 (-3.4, -2.1)*	**2006-2018**	-1.2 (-1.5, -1.0)*	**2018-2020**	4.4 (0.5, 8.4)*	----	----
60 to 79 years old	-1.3 (-1.9, -0.7)*	**2000-2007**	-2.0 (-2.5, -1.6)*	**2007-2015**	-1.0 (-1.5, -0.6)*	**2015-2018**	-3.1 (-6.4, 0.4)	**2018-2020**	3.3 (-0.3, 7.0)
80 years old and over	-1.6 (-1.8, -1.3)*	**2000-2007**	-2.0 (-2.7, -1.3)*	**2007-2020**	-1.3 (-1.6, -10.7)*	----	----	----	----
Ignored age group	-0.1 (-0.7, 0.5)	**2000-2012**	-1.3 (-2.0, -0.6)*	**2012-2020**	1.7 (0.4, 3.0)*	----	----	----	----
Race/color									
White	-0.8 (-1.3, -0.4)*	**2000-2007**	-1.4 (-1.1, -1.7)*	**2007-2015**	-0.4 (-0.8, -0.1)*	**2015-2018**	-2.4 (-4.9, 0.3)	**2018-2020**	2.0 (-0.7, 4.7)
Black	-1.0 (-1.8, -0.3)*	**2000-2003**	-0.7 (-2.8, 1.5)	**2003-2006**	-4.2 (-8.2, -0.1)*	**2006-2018**	-1.0 (-1.3, -0.7)*	**2018-2020**	3.1 (-1.2, 7.7)
Indigenous	-1.6 (-2.5, -0.6)*	**2000-2005**	-4.2 (-5.5, -3.0)*	**2005-2014**	-0.4 (-1.0, 0.3)	**2014-2017**	-6.3 (-11.7, -0.6)*	**2017-2020**	4.6 (1.5, 7.8)*
Yellow	-1.0 (-1.2, -0.7)*	**2000-2020**	-1.0 (-1.2, -0.7)*	----	----	----	----	----	----
Ignored race/color	-1.6 (-2.7, -0.4)*	**2000-2012**	-2.0 (-2.4, -1.7)*	**2012-2015**	0.4 (-5.2, 6.3)	**2015-2018**	-4.2 (-9.5, 1.4)	**2018-2020**	2.3 (-3.4, 8.3)
Region of residence									
North	-1.3 (-2.2, -0.5)*	**2000-2018**	-2.2 (-2.5, -2.0)*	**2018-2020**	7.4 (-1.9, 17.5)	----	----	----	----
Northeast	-1.8 (-2.9, -0.7)*	**2000-2003**	-0.6 (-4.2, 3.1)	**2003-2006**	-7.2 (-13.8, -0.1)*	**2006-2020**	-0.9 (-1.3, -0.6)*	----	----
Southeast	-0.4 (-0.7, -0.2)*	**2000-2006**	-1.2 (-1.6, -0.9)*	**2006-2018**	-0.6 (-0.7, -0.4)*	**2018-2020**	2.6 (0.6, 4.7)*	----	----
South	-1.2 (-1.2, -1.5)*	**2000-2014**	-0.5 (-0.7, -0.2)*	**2014-2020**	-2.9 (-3.8, -1.9)*	----	----	----	----
Midwest	-1.4 (-2.2, -0.6)*	**2000-2015**	-1.4 (-1.6, -1.2)*	**2015-2018**	-5.8 (-10.2, -2.7)	**2018-2020**	5.9 (0.9, 11.1)*	----	----
Brazil	-1.0 (-1.6, -0.4)*	**2000-2007**	-2.1 (-2.5, -1.6)*	**2007-2015**	-0.7 (-1.1, -0.2)*	**2015-2018**	-2.3 (-5.8, 1.2)	**2018-2020**	3.2 (-0.4, 7.0)

P-value < 0.05.

Source: Authors.

For levels 1 and 2, after continuous reduction, there was an increase from 2018 (APC = 5.3; 95%CI = [2.3, 8.5]; P = 0.003 for level 1 and APC = 11.4; 95%CI = [3.3, 20.2]; P = 0.008 for level 2). For level 3, after an initial period of increase, there was a decrease after 2013 and a trend reversal after 2018 (APC = 15.1; 95%CI = [7.3, 23.5]; P = 0.001). For level 4, a continuous increase was observed until 2016, followed by a decrease (APC = -6.0; 95%CI = [-7.7, -4.3]; P = < 0.001).

Discussion

Between 2000 and 2020, 39.9% of deaths that occurred in Brazil were coded with GC, ranging from 46.8% in 2000 to 38.8% in 2020. A study carried out in 20 countries found that the proportion of these codes ranged from 7% to 66%[25]. Although underreporting and misclassification of deaths are old and universal problems[26], the proportion of GC could be observed to be unevenly distributed according to the sociodemographic characteristics of the victims. This observation has implications both for directing mitigation policies and for designing and validating redistribution algorithms used to correct the numbers of deaths from specific causes[27].

In the present study, the highest proportions of GC occurred for females. This result corroborates what was observed in a study carried out in Taiwan, in which the proportion of GC was 12.7% among men and 14.7% among women[7]. A study carried out in Norway also found higher proportions of the indicator in the female population, with proportions of 15.6% of GC among women and 12.5% in men for the main codes[14].

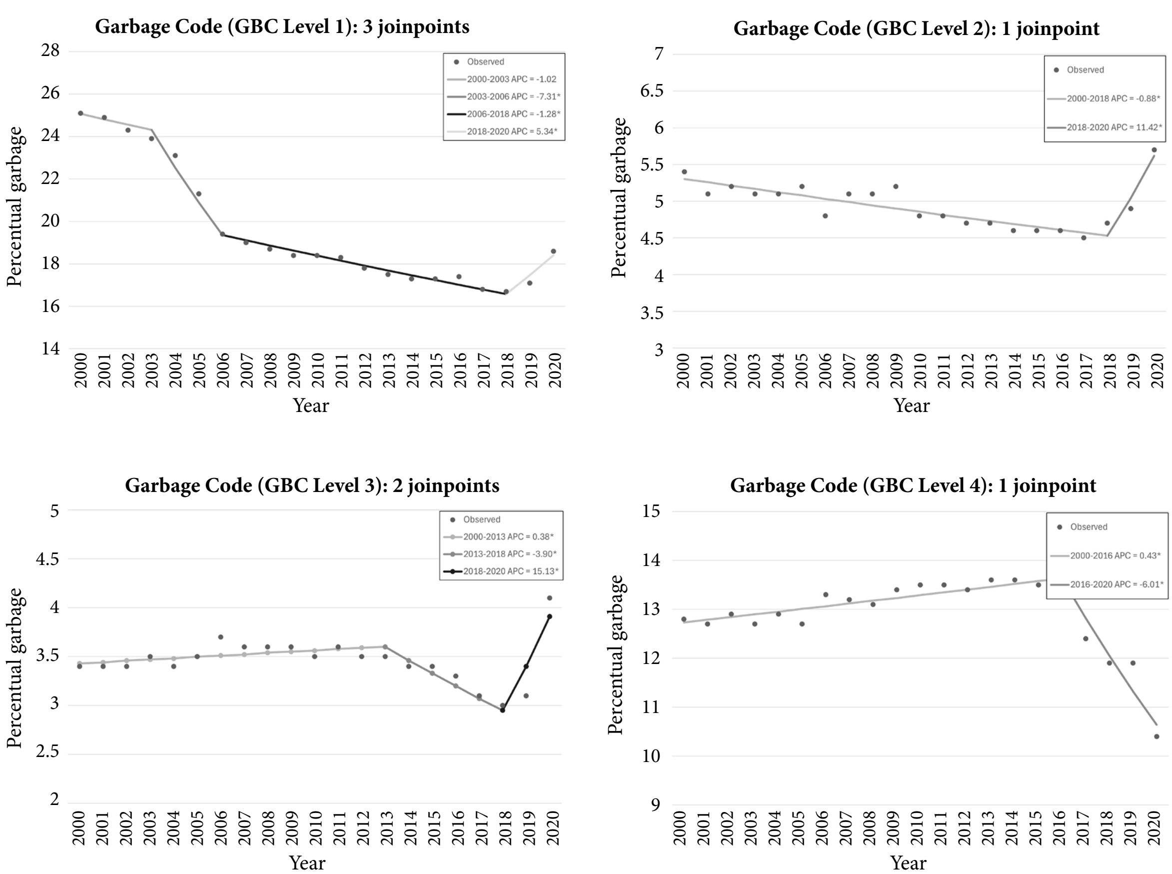

Figure 2. Trend in the proportion of GC by level, Brazil (2000 to 2020).

* Indicates that Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.

Source: Authors.

Deaths from external causes are more common among men than among women. These are attested by coroners after necropsy reports and the circumstances of the injuries are investigated in a police report by the Municipal Health Department, leading to a specific diagnosis of the cause of death. By going through this more thorough investigation process, deaths from external causes have better quality for the underlying cause filled out. Thus, the proportion of GC is lower for this type of death, and, consequently, for the male population[2,13].

Regarding age group, the highest proportion of GC occurred among the elderly, mainly in the age group over 80 years old. Several studies show concordant results, with a higher proportion of GC in older age groups[7,9,28]. The higher proportions of ill-defined causes among the elderly are probably due to the greater number of comorbidities, such as neoplasms, hypertension, diabetes and other cardiovascular diseases, hindering the provision of information about the underlying cause of death when filling out the death certificate, even after the use of verbal autopsies[9]. According to Ellingsen *et al.*[14], elderly people often have multiple illnesses and it can be challenging to identify a single cause of death. The authors also suggest that, as the end-of-life approaches, the focus of health care may be more on symptom relief than on identifying and treating the exact cause[14]. High proportions of GC were also observed in the age group of 1 to 9 years. Although other studies report similar situations[9,28], high proportions of GC in this age group are worrying, as it essential for surveillance to correctly identify the main causes of death among children[9]. The high proportion of GC has been associated with the etiological diagnosis of pneumonia. Many of the deaths caused by this disease, which is more common in children and the elderly, have the underlying cause coded as "non-specific pneumonia" (a GC level 4). This represents a challenge, considering that the request for microbiological examinations is not routinely performed in health services and its high cost makes the adoption of this practice at a population level in the short term unfeasible[29].

The variability in the proportion of GC according to the victims' race/color can be explained by the high proportion of deaths with unknown race/color, which affects the specific proportions. As widely acknowledged, the race/color category is a particularly complex definition and measurement variable. In the specific case of setting up mortality databases, the limits for classifying race/color are quite obvious, including the impossibility of applying the most widely recommended procedure, that is, self-classification[30]. Due to the importance of studying the causes of death according to the victim's race/color, it is necessary to direct continuous efforts to resolve this limitation.

Among the Brazilian regions, the Northeast had the highest proportions of GC throughout the period analyzed, followed by the North region. The exception was 2020, when the Southeast Region took the second place. A study carried out in the Northeast region of the country found that 1/3 of all deaths in the region had the underlying cause coded as GC[1]. Ishitani *et al.* observed that Rio de Janeiro was the Brazilian capital with the highest proportions of GC from 2011 to 2013, reaching a value of 36.7%. However, in the same period, except for Rio de Janeiro, the highest proportions of these causes of death were observed in the capitals of the North and Northeast regions[2]. Marinho *et al.*[31] pointed out higher proportions of GC in municipalities in the Northeast and Southeast regions, among the 60 cities analyzed in 2017. Lima *et al.*[32] highlighted that, although higher proportions of GC were observed in the North and Northeast regions in their study, the proportions are high throughout the country.

Between 2000 and 2018, a reduction was observed in the proportion of total Garbage Codes and for most studied disaggregation. This reduction indicates progress in strengthening statistics on causes of death in the country. Our findings are supported by the results of the rating system developed for the GBD2016 study – the Data Quality Rating (GBD). The calculation of this classification is based on the following variables: completeness of death registration, proportions of deaths not coded for GC levels 1 or 2, and fraction of deaths attributed to detailed causes of GBD. The score for Brazil improved from 68.9 in 1995-1999 to 82.5 in 2010-2017, although it remained a 4-star country in this 1–5-star rating. In the latter period, some high-income countries, such as Germany (score = 84.0), the Netherlands (83.3) and Japan (81.3), were also rated 4-star. In turn, in South America, Chile and Colombia were rated 5-star, but Uruguay, Paraguay and Argentina were rated 4-star[33]. Although there is evidence that there is an inverse relationship between the socioeconomic level of a country and its proportion of Garbage Codes, Brazil is among the five countries classified as having a medium or low level of development and has good performance information systems on mortality. These five countries invested in improving the quality of their mortality reporting systems[25].

These advances were the result of efforts by the Ministry of Health in a partnership with the federative units and municipalities to improve the capture of deaths by SIM. There were several initiatives, such as strengthening the inter federative pact and involving local managers in surveillance, and improving the quality of information systems, improving investigations and surveillance of death, and expanding primary health care besides increasing access to health care. Examples of these efforts are the project to reduce ill-defined causes in 2005 and the project to reduce regional inequalities and infant mortality in the states of the Northeast Region and the Legal Amazon. Also noteworthy is the active death search project, which allowed defining methodologies for redistributing under-registered deaths[15]. Another important initiative was the investigation of deaths with causes of death classified as GC, for identifying the factors that favor the maintenance of high proportions of this indicator. This initiative permitted to prepare normative and informative material on the subject; 60 cities in the five regions of the country currently participate in it, with a forecasted expansion in the coming years[1,31].

Thus, the decline in the GC proportion was the result of the specific investment made by the Ministry of Health to improve vital information. This involved everything from regulating data collection, the flow and frequency of sending information on deaths, to the dissemination of data and publication techniques, besides training of human resources, especially root cause coders, among other measures[1]. This commitment, together with the corrections, was essential for a more adequate interpretation and comparability of the historical series in the different regions of the country[15]. The GC research effort is an important strategy to encourage the improvement of the quality of data and information, bearing in mind that the main problems are related to filling in the underlying causes in the death certificate[1]. Additionally, a continuous effort was made to increase SIM coverage. Between 2000 and 2017, this coverage went from 86% to 98%, although some states in the North and Northeast still maintain coverage below 95%[34]. Some of the trend changes in the GC proportion may also be associated with this increase in SIM coverage[35].

Although the effectiveness of actions to reduce the proportion of GC in Brazil is undeniable, the maintenance of this trend depends on the continuity of such actions. Therefore, despite the great progress observed in the quality of mortality statistics in Brazil until 2018, a reversal of the trend was observed afterwards, with an increase in the proportion of GC. This proportion in Brazil in 2018 was 36.3%, the lowest observed since 2000. After that year, there was an increase, reaching 36.9% in 2019 and 38.8% in 2020. According to the Atlas of Violence 2021, a study prepared in a partnership convening the Brazilian Public Security Forum, the Institute of Applied Economic Research, of the Ministry of Economy, and the Jones dos Santos Neves Institute, the number of violent deaths due to an undetermined cause jumped from 12,310 to 16,648 between 2018 and 2019 in Brazil, which represents an increase of 35.2% in one year[36]. Attributed to the demobilization of the Ministry of Health and of several States for actions aimed at the qualification of data on mortality, this movement that increased the proportion of reported deaths with undetermined causes from 2018 came to be called "data blackout"[37].

A worsening of the situation could be observed during the pandemic caused by COVID-19, leading to a greater increase in the proportion of GC. The demands of the pandemic may have affected the accuracy of COVID-19 cause-of-death attribution in several converging ways. For example, the time and diligence of properly completing the medical certificate of cause of death, the international standardized death certificate, on which the quality of SIM data depends, may have been affected. Additionally, the overloaded medical professionals and health services, in addition to the difficulty in accessing diagnostic tests, particularly at the beginning of the pandemic, may have impacted the increase in the proportion of GC in this period.

Thus, the study in this article clarifies the problems experienced after 2018, highlighting the need for new actions. In addition, it shows that actions, even if successful, need to be repeated periodically, otherwise, quick regression may occur, besides loss of all the benefits and successes achieved.

High proportions of deaths from these causes indicate not only worse quality of cause of death statistics, but also lower access to health services and quality of medical care, especially among the poor population. Actions for qualifying information should more constantly and permanently include training aimed at physicians and coders for proper information recording[1]. Marinho *et al.*[31] observed that there is little knowledge among physicians about correctly completing the sequence of causes of death on the death certificate and, even more so, what concerns the concept of underlying cause of death. Therefore, to improve the quality of information on the cause of death in the medical certificate, it is necessary to invest in efficient communication with physicians, with dissemination of knowledge, instructions and examples of filling out the death certificate, in addition to other interactive forms. It is also necessary to better prepare medical students and resident physicians to correctly complete a death certificate[31]. Also notice that variations in the mortality pattern of the population, as observed during the COVID-19 pandemic, can also lead to changes in the proportion and distribution of GC[14].

In addition to reinforcing proven effective measures to reduce the proportion of GC, the adoption of the 11th Revision of the International Classification of Diseases (ICD-11) and Related Health Problems is expected to contribute to mitigate this problem. Launched from the 72nd World Health Assembly in May 2019, ICD-11 represents a system based on formal ontology, designed to be implemented in modern information technology infrastructures and able to capture the clinically relevant characteristics of cases and allow the summarization of information[38]. Although it has been in force since January 2022, the use of the ICD-11 by health professionals in Brazil should only occur from 2025 onwards, after an extensive process of translation and revision by the Ministry of Health[39].

The reduction in the proportion of GC in the period from 2000 to 2018 was mainly caused by the decrease in the number of deaths coded with level 1 GC. GC of this group which has been carried out by the Ministry of Health (MS) since 2005 with the implementation of actions that can lead to its reduction[9]. The predominance of level 1 GC in the country is worrying, as these causes have a greater impact on public health. According to Anaconda, an instrument for verifying the quality of mortality data, GC levels 1 to 3 are classified as more serious unusable causes, due to the greater risk of misleading public policies[9].

During the pandemic, there was a sudden increase in the proportion of level 2 GC, probably driven by the lack of specific codes for COVID-19 and the overload of health services and death surveillance. In May 2020, the Ministry of Health standardized the coding of causes of death reported in the Death Certificate in the context of COVID-19, aiming at processing and selecting the underlying cause, in accordance with the SIM[40]. The U07 category, recommended by the World Health Organization to identify and monitor deaths from COVID-19, was not included in the version of the ICD-10 used in Brazil. Thus, it was not possible to select these codes to fill in the underlying cause during the step of entering the death certificates. In this context, for using codes U07.1 (COVID-19, identified virus) and U07.2 (COVID-19, unidentified virus), a maintenance file was developed in the SIM for data from death certificates with these conditions[19], thus allowing their insertion.

The data presented here may differ from other studies using different GC lists. The use of the list proposed by the GBD in 2017 means that comparability with data from studies that use different lists is lost[14,32], including those presented in the Monitoring Panel of Mortality due to Unspecific or Incomplete underlying causes of the Integrated Health Surveillance Platform of the Brazilian Ministry of Health[41]. However, the GBD study was a pioneer in listing causes that cannot or should not serve as the underlying cause of death and has been used as a reference for most international works on the subject[20,27].

Conclusions

The accuracy of mortality data is essential to correctly support the planning of health actions, monitoring disease trends, evaluating public policies, identifying the most vulnerable populations, among other actions[38]. The present study shows the impact of the GC on the final estimates of mortality in Brazil. The quality of data and information on deaths is still a major challenge in Brazil, since there are inequalities in the coverage and quality of data and information on the causes of death[2]. The proportion of GC is a relevant indicator to assess the quality of the Mortality Information System. High proportions of GC can impair the analyses, especially when it comes to more stratified analyses, such as specific causes, according to age and sex or in small areas[6,9], as those presented here. When carrying out analyses of mortality indicators, it is necessary to consider that the magnitude of the rates is affected by these causes, introducing bias in comparisons between places or populations with different proportions of GC and in studies of temporal trends[20]. Johnson *et al.*[42] demonstrated that the profile of causes of death was altered by the redistribution of GC in Brazil and in four other countries (United States, Japan and France), highlighting the need to account for deaths coded with these causes The completeness and quality of attribution of the cause of the impact of death on mortality statistics[27,43]. Those deaths reported with an unspecific cause are of low quality, as they lose their usefulness regarding their decision-making by the health sectors in the country[10].

In Brazil, large differences persist between states and regions in relation to the proportion of GC. This variation also occurs intra-regionally, with very high proportions in some state macro-regions. The inequality of this indicator can also be observed as regards age group, sex and race/color of the victim[10], as shown in Table 1 of the Results. Reducing the proportion of GC, converting them into useful codes for public health analysis, allows managers to more adequately plan health policies for the population[9].

Declarations

The data plan for this article can be consulted at: https://doi.org/10.48321/D15W40[1]. The dataset supporting the conclusions of this article are available in the USP Digital repository: https://repositorio.uspdigital.usp.br/handle/item/477.

Collaborations

EC Aquino, SL Borowicc and SN Alves-Souza conceptualized, drafted, developed, and finalized the manuscript. RA Teixeira, LH Ishitani, DC Malta and OL Morais Neto provided comments on the draft manuscript. All authors read and approved the final version of the manuscript.

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