Trends in mortality from leading causes in Brazil from 2011 to 2020: an ecological study

Abstract

Introduction: Deaths show the epidemiological scenario of the community and allow the planning of effective strategies for the prevention of deaths, mainly by immunopreventable and preventable causes, but for this the surveillance of death must have quality. Epidemiological studies should be carried out periodically to verify the epidemiological pattern of the causes. **Objective:** To investigate the trends of mortality from leading causes in Brazil from 2011 to 2020. **Methodology:** Ecological study, secondary bases, with data from national surveillance. Descriptive analysis of deaths by federation unit was performed, and graph with the six leading causes and trend, by the R2 equation. We calculated the mortality rate of 2011 and compared it with 2020, presented in choropleth map. The data were analyzed in Excel 2019. **Results:** Deaths totaled 12,899,133 million, the six leading causes in highest numbers were: IX Diseases of the circulatory system 3,498,722 (27.12%) upward trend 81%, II Neoplasms (tumors) 2,114,222 (16. 39%) increasing trend 96%, XX External causes of morbidity and mortality 1,512,786 (11.73%), X Respiratory system diseases 1,459,945 (11.52%) increasing trend 71%, IV Endocrine, nutritional and metabolic diseases 786,693 (6.10%) increasing trend 80%. We highlight the highest mortality rates in the federal units in the southeast, south, and northeast of Brazil. Rio de Janeiro had the highest mortality in 2011 611/100,000 inhabitants and also in 2020 785/100,000 inhabitants. Followed by Rio Grande do Sul in 2011 596/100,000 inhabitants and 2020 650/100,000 inhabitants. **Conclusion:** We evidenced the tendency of increase in diseases of the circulatory system, respiratory, neoplasms and metabolic endocrine. Highlighting for neoplasms leading all causes, followed by diseases of the circulatory system, which was already known as the leading cause and annual increase.

Key words: Death Surveillance; Health Indicators; Epidemiology; Brazil.

INTRODUCTION

The surveillance of death is an essential tool for any country in the world to develop health policies, for quality of life and greater longevity [1]. Brazil is a developing country that has a large geographic extension, and heterogeneity among regions, mainly due to the diversity of biomes, traditional peoples, and means of extraction. These factors interfere with access to education, health, and income. The North and Northeast regions of the country are the most vulnerable, and consequently have the highest mortality rates from immunopreventable and preventable diseases[2,3].

The illegal exploitation of minerals causes uncontrolled environmental contamination of mercury, especially in the Brazilian Amazon area, directly affecting the health of the regional and indigenous population[4–6].

Another characteristic is schooling and income, only 21% of the Brazilian population has higher education, and the wealth is concentrated in less than 1% of the population, being a country with huge social inequality. The programs of access to education and income are still very weak in Brazil[7].

All these factors are responsible in some way for the contribution of mortality in the country. Therefore, death surveillance is the main strategy for providing information on the epidemiological scenario of the causes of deaths by municipality. In Brazil, death surveillance is carried out by the Mortality Information System (SIM), which has tripartite management, federal, state and municipal, this decentralization is essential for the quality of epidemiological data. A ferramenta da vigilância, é a declaração de óbito, que é preenchida exclusivamente pelo profissional médico no óbito por julgamento clínico, e também nas autopsias e serviço de verificação dos óbitos no domicílio pelo médico da familia[8].

The SIM surveillance works with universal indicators agreed with the Pan American Health Organization (PAHO), which are general mortality, infant mortality, maternal mortality, and mortality from communicable diseases. These indicators show the scenario of the population and each region,

and are used for planning health promotion strategies, and health prevention strategies at all levels of health care.[9].

Epidemiological studies of deaths should be carried out periodically for the evaluation of indicators, and interpretation of the epidemiological pattern and even the change in the behavior of curves in time series. Thus, the objective of this study is to investigate the trends of mortality from major causes in Brazil from 2011 to 2020.

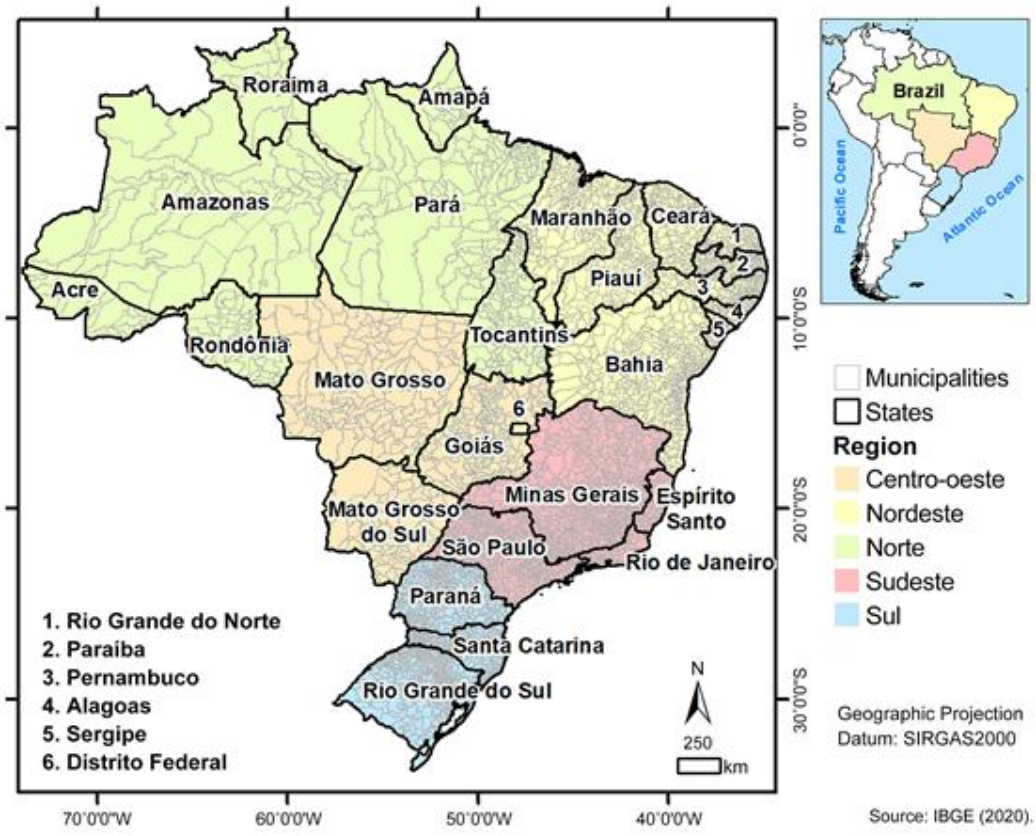
METODOLOGÝ

This is an ecological study, with death surveillance data from the Mortality Information System (SIM), which are made universally and openly available by the public health data platform, at Department of Informatics of the Unified Health System (DATASUS) (https://datasus.saude.gov.br/), through the Health Information (TABNET) in Mortality (Mortality Information System (SIM), as well as Resident Population. Data from 2011 to 2020 and from all age groups were analyzed.

The study site was Brazil, located in South America, the largest country on the continent, with a tropical climate, diverse biomes, traditional peoples, and regional vulnerabilities. The population according to the 2010 census conducted by the Brazilian Institute of Geography and

Statistics (IBGE) was 190,755,799 inhabitants (22.43 inhabitants per square kilometer), with a male to female ratio of 0.96:1 and 84.36% of the population defined as urban. The population is strongly concentrated in the Southeast (80.3 million inhabitants), Northeast (53.1 million) and South (27.4 million), while the two largest regions, the Center-West and the North, which form almost two thirds of the national territory, have a total of only thirty million inhabitants[10].

Figure 1 - Regions and federation units in Brazil.



Source: Sardinha, 2021 [11].

The data was collected on April 07, 2023, we did not include 2021 as it was not available on the platform, as surveillance data is published after the data processing period. The analysis was performed by Excel 2019, from the tabulation and descriptive analysis of the absolute and relative number, which we present in tables. We calculated mortality, following the formula (number of deaths / by resident population of the year X 100,000), for the main causes of deaths. We also performed to investigate the trend, the R^2 equation, which was presented in graphs. With the mortality rate we created a choropleth map, with warm colors for higher mortality rates, from the federation units of the country, we also performed in Excel 2019.

Our analysis parameter was the chapters of the International Classification of Diseases (ICD-10). The chapters are: I. Certain infectious and parasitic diseases, II. Neoplasms (tumors), III. Hematologic blood organ diseases and immune disorders, IV. Endocrine nutritional and metabolic diseases, V. Mental and behavioral disorders, VI. Diseases of the nervous system, VII. Diseases of the eye and adnexa, VIII. Diseases of the ear and mastoid apophysis, IX. Diseases of the circulatory system, X. Diseases of the respiratory system, XI. Diseases of the digestive system, XII. Diseases of the skin and subcutaneous tissue, XIII. Osteomuscular and Connective Tissue System Diseases, XIV. Genitourinary system diseases, XV. Pregnancy, childbirth and puerperium, XVI. Some diseases originated in the perinatal period, XVII. Congenital malformations deformities and chromosomal anomalies, XVIII. Symptoms signs and abnormal findings clinical and laboratory examination, XIX. Injuries poisoning and some other consequences external causes, XX. External causes of morbidity and mortality, XXI. Health care contacts, XXII. Special Purpose Codes.

The study did not require Research Ethics Committee (REC) approval because we analyzed public and universal open access data. The data are in aggregated format and do not contain personal data of the patients.

RESULTS

We analyzed a time series from 2011 to 2020 in the number of deaths in Brazil according to the ICD-10 chapter classification. Deaths totaled 12,899,133 million, the six leading causes in greatest numbers were: IX Diseases of the circulatory system 3,498,722 (27.12%), II Neoplasms (tumors) 2,114,222 (16.39%), XX External causes of morbidity and mortality 1,512,786 (11.73%), X Respiratory system diseases 1,459,945 (11.52%), IV Nutritional and metabolic endocrine diseases 786,693 (6.10%) and I Some infectious and parasitic diseases 748,731 (5.80%) (table 1).

In figure 1 we analyze the six main causes according to the ICD-10 chapters, and calculate the R^2 to verify the tendency for reduction, stabilization or increase in the selected time series. The IX Circulatory system diseases showed a tendency to increase, with up to 81% in the years analyzed, likewise the II Neoplasms (tumors) were those that most represented an increase, up to 96%, followed by X Respiratory system diseases up to 71% and the IV Endocrine, nutritional and metabolic diseases up to 80%. The other causes XX External causes of morbidity and mortality 0.04% and I Some infectious and parasitic diseases 30% showed no upward trend. But it is worth noting the increase in the number of deaths in I Some infectious and parasitic diseases in 2020 caused by COVID-19, which we can observe in the curve.

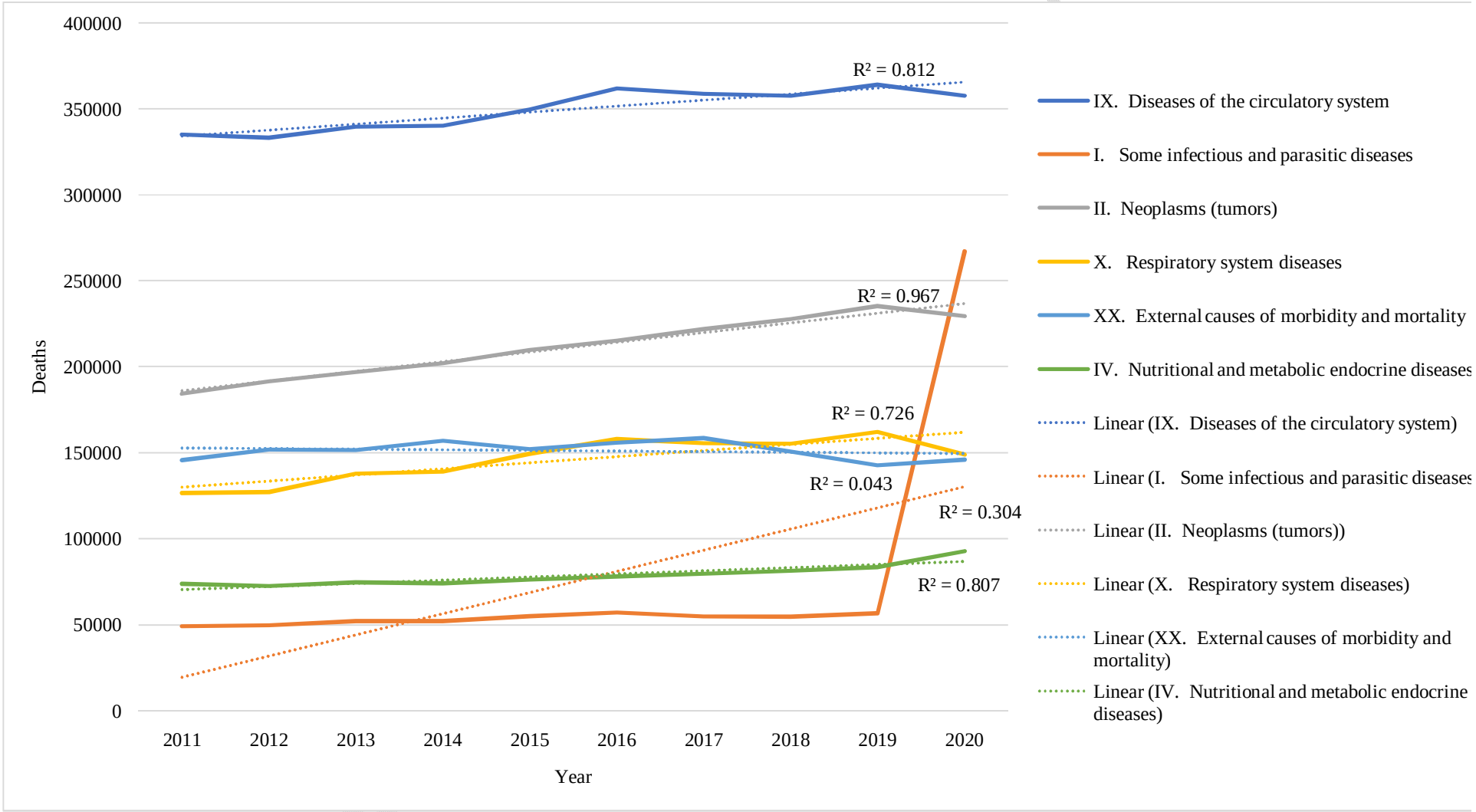
In the mortality rate, we performed for 2011 and for 2020 to compare by federation unit of Brazil, considering the six main causes according to ICD-10 chapters (table 2). For better visualization we present the mortality rates per federal unit through choropleth maps, where the warmer colors show the higher mortality rates. We highlight the highest mortality rates in the federal units in the southeast, south, and northeast of Brazil. Rio de Janeiro had the highest mortality in 2011 611/100,000 inhabitants and also in 2020 785/100,000 inhabitants. Followed by Rio Grande do Sul in 2011 596/100,000 inhabitants and in 2020 650/100,000 inhabitants (figure 2 and 3).

Table 1 - Number of deaths by ICD-10 chapter in Brazil from 2011 to 2022.

ICD-10 Chapter	2011	%	2012	%	2013	%	2014	%	2015	%	2016	%	2017	%	2018	%	2019	%	2020	%	Total 12,899,133	%
IX. Diseases of the circulatory system	335,213	9.58	333,295	9.53	339,672	9.71	340,284	9.73	349,642	9.99	362,091	10.35	358,882	10.26	357,770	10.23	364,132	10.41	357,741	10.22	3,498,722	27.12
I. Some infectious and parasitic diseases	49,175	6.57	49,608	6.63	52,058	6.95	52,174	6.97	55,022	7.35	57,188	7.64	54,874	7.33	54,679	7.3	56,666	7.57	267,287	35.7	748,731	5.8
II. Neoplasms (tumors)	184,384	8.72	191,577	9.06	196,954	9.32	201,968	9.55	209,780	9.92	215,217	10.18	221,821	10.49	227,920	10.78	235,301	11.13	229,300	10.85	2,114,222	16.39
X. Diseases of the respiratory system	126,693	8.68	127,204	8.71	137,832	9.44	139,045	9.52	149,541	10.24	158,041	10.83	155,620	10.66	155,191	10.63	162,005	11.1	148,773	10.19	1,459,945	11.32
XX. External causes of morbidity and mortality	145,842	9.64	152,013	10.05	151,683	10.03	156,942	10.37	152,136	10.06	155,861	10.3	158,657	10.49	150,814	9.97	142,800	9.44	146,038	9.65	1,512,786	11.73
IV. Nutritional and metabolic endocrine diseases	73,929	9.4	72,495	9.22	74,726	9.5	73,972	9.4	76,235	9.69	78,075	9.92	79,662	10.13	81,365	10.34	83,485	10.61	92,749	11.79	786,693	6.1
XVIII. Symptoms abnormal signs and findings clinical and laboratory examination	78,363	10.43	74,935	9.97	71,804	9.55	71,191	9.47	71,713	9.54	75,869	10.1	71,822	9.56	70,505	9.38	74,972	9.98	90,345	12.02	751,519	5.83
XI. Diseases of the digestive tract	59,707	9.27	60,509	9.4	61,934	9.62	62,763	9.75	64,202	9.97	66,044	10.26	66,052	10.26	67,316	10.45	68,770	10.68	66,667	10.35	643,964	4.99
VI. Nervous System Diseases	26,948	7.47	28,712	7.96	30,300	8.4	32,381	8.98	34,721	9.63	36,870	10.23	38,786	10.76	41,035	11.38	45,235	12.54	45,598	12.65	360,586	2.8
XIV. Diseases of the genitourinary system	26,317	7.14	27,975	7.59	29,709	8.06	32,510	8.82	36,549	9.91	39,367	10.68	40,470	10.97	43,428	11.78	47,566	12.9	44,860	12.17	368,751	2.86
XVI. Some conditions originating in the perinatal period	23,579	10.89	23,069	10.66	22,745	10.51	22,482	10.39	22,162	10.24	21,049	9.73	21,458	9.91	20,764	9.59	20,354	9.4	18,770	8.67	216,432	1.68
V. Mental and Behavioral Disorders	13,725	10.14	12,641	9.34	13,052	9.64	12,480	9.22	12,558	9.28	12,674	9.36	12,858	9.5	13,697	10.12	14,526	10.73	17,168	12.68	135,379	1.05
XVII. Congenital malformation, deformities and chromosomal abnormalities	10,543	9.76	10,622	9.84	10,752	9.96	11,050	10.23	10,989	10.18	10,882	10.08	10,995	10.18	11,156	10.33	11,308	10.47	9,673	8.96	107,970	0.84
XII. Skin and subcutaneous tissue diseases	3,395	6.47	3,722	7.09	3,919	7.46	4,300	8.19	4,970	9.47	5,874	11.19	6,100	11.62	6,273	11.95	7,152	13.62	6,796	12.94	52,501	0.41
III. Hematologic blood organ diseases and immune disorders	6,344	9.69	6,358	9.71	6,388	9.76	6,108	9.33	6,506	9.94	6,878	10.51	6,622	10.11	6,601	10.08	7,068	10.8	6,596	10.07	65,469	0.51
XIII. Osteomuscular and Connective Tissue System Diseases	4,488	8.12	4,607	8.33	5,001	9.04	5,325	9.63	5,385	9.74	5,787	10.47	5,912	10.69	6,153	11.13	6,506	11.77	6,128	11.08	55,292	0.43
XV. Pregnancy, childbirth and puerperium	1,680	9.17	1,647	8.99	1,787	9.75	1,889	10.31	1,896	10.35	1,814	9.9	1,874	10.23	1,862	10.16	1,726	9.42	2,147	11.72	18,322	0.14
VIII. Diseases of the ear and mastoid apophysis	150	9.22	139	8.54	143	8.79	157	9.65	147	9.04	173	10.63	179	11	169	10.39	206	12.66	164	10.08	1,627	0.01
VII. Diseases of the eye and appendages	23	10.36	38	17.12	15	6.76	18	8.11	21	9.46	20	9.01	19	8.56	21	9.46	23	10.36	24	10.81	222	0

Source: DATASUS.

Figure 2 - Time trend of deaths from the 6 (six) leading causes according to the ICD-10 chapters in Brazil from 2011 to 2020.



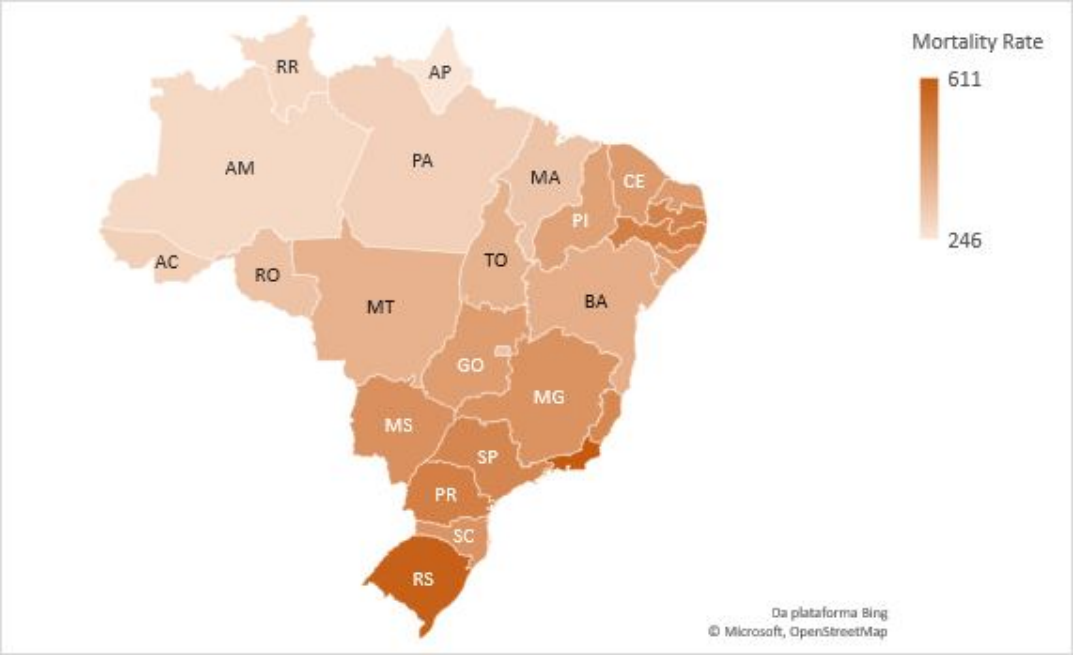
Fonte: DATASUS.

Table 2 - Mortality rate per 100,000 inhabitants considering the 6 (six) main causes according to the ICD-10 chapters in Brazil in 2011 and 2020.

Federation Unit	Mortality Rate 2011	Federation Unit	Mortality Rate 2020
RO	337	RO	465
AC	302	AC	405
AM	278	AM	455
RR	275	RR	469
PA	300	PA	475
AP	246	AP	442
TO	378	TO	490
MA	332	MA	496
PI	422	PI	583
CE	441	CE	621
RN	440	RN	573
PB	500	PB	616
PE	512	PE	646
AL	454	AL	585
SE	407	SE	519
BA	388	BA	540
MG	460	MG	546
ES	489	ES	601
RJ	611	RJ	785
SP	495	SP	603
PR	515	PR	583
SC	458	SC	531
RS	596	RS	650
MS	467	MS	555
MT	381	MT	540
GO	435	GO	564
DF	343	DF	433

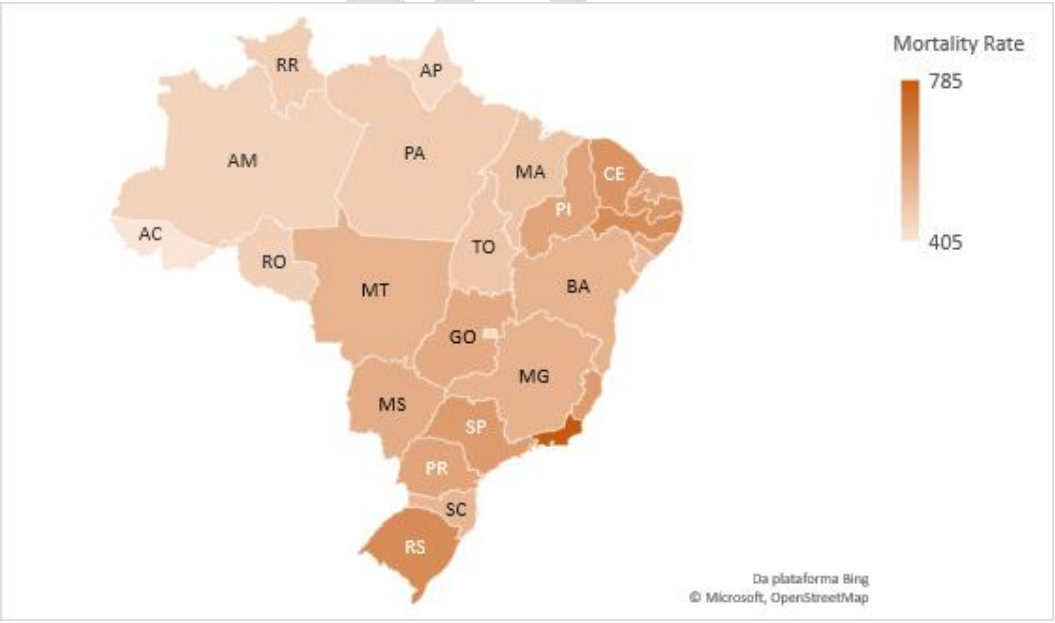
Source: DATASUS. (ICD-10 chapters I, II, IV, IX, X and XX).

Figure 3 - Mortality rate per 100 thousand inhabitants considering the 6 (six) main causes according to the ICD-10 chapters in Brazil in 2011.



Source: DATASUS. (ICD-10 chapters I, II, IV, IX, X and XX).

Figure 4 - Mortality rate per 100 thousand inhabitants considering the 6 (six) main causes according to the ICD-10 chapters in Brazil in 2020.



Source: DATASUS. (ICD-10 chapters I, II, IV, IX, X and XX).

DISCUSSION

Our ecological study evaluated deaths in Brazil by the causes of higher occurrence in the historical series from 2011 to 2020. Our parameter of the causes of deaths were the chapters of ICD-10. So, we analyzed the chapters, IX Diseases of the circulatory system, II Neoplasms (tumors), XX External causes of morbidity and mortality, X Diseases of the respiratory system, IV Nutritional and metabolic endocrine diseases and I Some infectious and parasitic diseases, which were the chapters that accounted for the largest number of deaths.

Neoplasms (tumors) showed the greatest tendency to increase among all other causes. A previous study conducted from 1990 to 2015 showed a reduction in deaths from neoplastic causes in more developed states and an increase in more vulnerable ones, such as the North of Brazil. However, they evaluated by sex and type of cancer[12]. In our study we showed a very large increase trend, which may be associated with better cancer surveillance in Brazil in recent years or even the uncontrolled advance of the disease and death. We also found higher mortality rates in the southeastern and southern regions, similar to another study from 2002 to 2004[13], showing the same epidemiological behavior.

A research highlights the vulnerabilities by region of the country in the influence of the highest mortality rates in Brazil, for being a country with a large territorial extension and several biomes and people, heterogeneity occurs among the regions[14]. Another research evaluated the trend of cancer mortality in Brazil in the 1980's and already pointed to a high growth, especially in the south of the country [15]. In our study we show the same epidemiological pattern remains.

On the causes of circulatory system diseases, they represented the largest numbers of deaths in Brazil, with a tendency to increase. By 2015, a study identified a reduction in cardiovascular causes and a slight increase in neoplasms[16], already in our study, with the R^2 equation we show a tendency of growth until 2020.

Relative to other countries, an epidemiological study in Europe in 2020 highlighted that, cardiovascular disease remains the most common cause of death in the European region. More than 60 million die each year from cardiovascular disease in Europe, with more women than men, however in age standardized rates of morbidity and death from cardiovascular disease are higher in men than in women. Another important point is that deaths from cancer exceed those from cardiovascular disease in 15 of the 53 countries in the European region for men and in six countries for women[17]. A study in Iran highlights that the increase in Cardiovascular Diseases

(CVD) may be related to socioeconomic and cultural changes, nutritional transition, inadequate physical activity, industrialization and urbanization and increased life expectancy, increased metabolic and physical risk factors, low accessibility and low cost for primary care and treatment, and poor compliance due to economic and psychological problems. Strategies should be aimed at prevention and control of the disease and its risk factors, early detection of the disease, and treatment of acute and chronic CVD events[18].

A global study of CVD death trends from 1990 to 2017 showed that the CVD death rate decreased in high-income countries (1990: 271.8 (95% IU (uncertainty interval), 270.9-273.5);2017:128.5 (95% IU, 126.4-130.7) per 100. 000)), while it remained the same in low- and middle-income countries (1990: 368.2 (95% IU, 335.6-383.3);2017:316.9 (95% IU, 307.0-325.5) per 100,000). Among the various traditional risk factors, high systolic blood pressure, unhealthy diet, high fasting plasma glucose, and elevated low-density lipoprotein levels were attributed to most CVD death and disability-adjusted life years lost[19].

A large study evaluated CVD deaths in Brazil and how income and education influence deaths. The age-adjusted cardiovascular mortality rate for women with less than 8 years of schooling (compared with 8 years or more) was 3.75 (95% CI 3.29 to 4.28) in the one-fifth of the least developed states and 2.84 (95% CI 2.75 to 2.92) in the one-fifth of the most developed states (p value for linear trend=0.002). Among men, the corresponding rates were 2.53 (95% CI 2.32 to 2.77) and 2.26 (95% CI 2.20 to 2.31), respectively (p-value=0.258). There is strong evidence that low socioeconomic groups have a higher risk of cardiovascular disease, regardless of the stage of national economic development[20].

Another cause that was highlighted in our analysis was the upward trend in causes of death from nutritional and metabolic endocrine diseases. A large epidemiological study in Brazil on causes of death from Diabetes, combined data from death surveillance and the national health survey, and showed that despite a recent reduction in diabetes mortality rates, the burden of diabetes mortality is quite high in Brazil 9.1% when considering only self-reported diabetes and 14.3% when adding undiagnosed diabetes verified in a single determination. These data reinforce the importance of greater action by Brazilian society and governments to address the current epidemic of obesity and diabetes[21].

One study highlighted that future projections suggest that the diabetes mortality burden will increase by 144% by 2040 in Brazil, more than double the expected increase in the overall crude disease burden (54%). By 2040, diabetes is projected to be the third leading cause of death in Brazil and hyperglycemia its third leading risk factor, in terms of deaths[22]. Public health policies for the prevention of risk factors such as obesity, should be formulated urgently in Brazil, because it stands out the increase, and consequently Diabetes, which reflects in the causes of death, and that this is a reflection of the epidemiological transition that Brazil is facing[23].

Respiratory system diseases also showed a tendency to increase, similar to previous studies in some regions of Brazil, but also highlighting children and the elderly [24–26].

We emphasize the limitations of the research in analyzing secondary and aggregated epidemiological surveillance data, which increase the risk of bias, however the large number of deaths analyzed minimize the risk. Secondary data can be filled in incorrectly, however with the technology in the country, surveillance was enhanced in recent years in relation to data quality.

CONCLUSION

Our ecological study from 2011 to 2020 with data from epidemiological surveillance showed a tendency to increase in diseases of the circulatory system, respiratory, neoplasms, and metabolic endocrine. Highlighting for neoplasms leading all causes, followed by diseases of the circulatory system, which was already known as the leading cause and annual increase.

These results confirmed what the literature has previously described in Brazil, thus health policies should be directed to the prevention, early diagnosis and treatment of the user's chronic diseases, strengthening the health care networks and highlighting the vulnerabilities of each region of the country.

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