



ORIGINAL ARTICLE

Trends in suicide rates in Brazil from 1997 to 2015

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Objectives: To analyze time trends of suicide rates in Brazil overall and in Brazilian states and compare the estimated suicide rates projected for 2020 with the World Health Organization (WHO) Mental Health Action Plan target.

Methods: This was an ecological time-series study from 1997 to 2015, stratified by Brazilian states, specific age groups, and sex. Data were obtained from the Mortality Information System (Sistema de Informações sobre Mortalidade [SIM]) of the Brazilian Ministry of Health. Polynomial regression models were used to analyze the trends in suicide rates and to project suicide rates for 2020.

Results: Considering 224 units of analysis, 21 (9.4%) showed a decreasing trend, 108 (48.2%) were stable, and 95 (42.4%) showed an increasing trend. Thus, 67% of units of analysis will not meet the WHO target in 2020. Mean suicide rates were higher in males than in females. People aged 60 years and older presented the highest suicide rates, while 84.7% of total deaths by suicide occurred among 15-to-59-year-olds.

Conclusion: Overall, 90.6% of units of analysis had a stable or increasing trend in suicide rates from 1997 to 2015. If these trends remain, most of Brazil will fail to achieve the WHO-recommended reduction in suicide rates by 2020.

Keywords: Suicide; epidemiology; community mental health; public health; time series

Introduction

Suicide is a serious public health problem and one of the leading causes of death worldwide. According to the World Health Organization (WHO), close to 800,000 people die by suicide every year,¹ resulting in a global average rate of 10.6 per 100,000 individuals, which is projected to increase in the next decades.² In Brazil alone, approximately 10,000 individuals die by suicide per year, resulting in a crude suicide rate of 5.5 per 100,000 in 2015. In an attempt to counter these disheartening projections, Brazil and other countries, guided by the latest WHO Mental Health Action Plan,³ have been working toward a 10% reduction in their suicide rate by 2020 (considering 2012-year or 2013-year suicide rates as baseline).

With a population of more than 200 million, Brazil is the fifth largest country in the world and the eighth richest by Gross Domestic Product (GDP).⁴ Furthermore, it also has one of the world's highest levels of social and income inequality, which has a direct impact on population health and on causes of death such as suicide.⁵

It is known that suicide is a complex and multifactorial phenomenon that involves sociocultural, economic, psychological, biological, and environmental issues. Therefore, regional variations in suicide rates in a large, heterogeneous, developing country like Brazil are to be expected.

In such settings, time-series ecological studies can be an important epidemiological tool for formulating regional explanatory hypotheses and indirectly evaluating the effectiveness of public policies, as they allow forecasting and provide information on the distribution of events.⁶

Within this context, the aims of our study were to analyze time trends of suicide rates in Brazil overall and in individual Brazilian states from 1997 to 2015 and to compare projected suicide rates for 2020 with the WHO Mental Health Action Plan target.

Methods

This ecological study was an analysis of the time trend in suicide rates in Brazil as a whole and in Brazilian states from 1997 to 2015, stratified by sex and by age groups (15-29 years, 30-39 years, 40-59 years, and 60 years and older). In total, 224 units of analysis were studied.

All data were obtained from official secondary sources. The number of suicides was obtained from the Mortality Information System (Sistema de Informações sobre Mortalidade [SIM]) database, maintained by the Brazilian Ministry of Health. The population of each state was obtained from the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística

[IBGE]); census data were used for years in which censuses were performed, and interpolated data for the other years. Both datasets are publicly available online.⁷

Suicide was defined as death resulting from intentional self-harm according to the ICD-10, which uses codes X60 to X84 and Y87 to identify this outcome.

The 1997-2015 time series was composed of annual suicide rates. These were calculated by dividing the total number of suicides by the number of population and multiplying the quotient by 100,000, for Brazil and each of its states. Analyses stratified by sex and age group were performed. Values corresponding to unknown age were excluded.

To evaluate whether the trend in suicide rates increased, decreased, or remained stable during the study period, polynomial regression models were used ($y = \beta_0 + \beta x$). Suicide rates were considered as dependent variables (y), and the calendar years as independent variables (x). To avoid self-correlation between the terms of the regression equation, the calendar years were transformed into a year-centralized variable (x minus the midpoint of the historical series). A trend was considered significant when its estimated model obtained $p < 0.05$. Homoscedasticity and normality of distribution were assumed.

Estimated suicide rates projected for 2020 (using polynomial regression models and the 1997-2015 time series) and the WHO Mental Health Action Plan 10% reduction target³ were compared, using 2013-year rates as baseline data instead of 2012-year rates because there were no relevant differences between them and because 2013 data are more recent. All analyses were carried out in Stata version 14.0.

In accordance with Brazilian National Health Council Resolution 466/2012,⁸ this study was exempt from evaluation by a research ethics committee, since it used only secondary data available from official Brazilian Ministry of Health databases.

Results

According to official data, from 1997 to 2015, 164,276 suicides occurred in people aged 15 years and over in Brazil. Men accounted for 79.3% of total deaths. Considering the age groups analyzed, 32.4% of deaths occurred among people aged 40-59, 30.7% among people aged 15-29, 21.6% among people aged 30-39, and 15.3% among people aged 60 years and over.

The mean rates in women ranged from 0.89 (Acre, age ≥ 60 years) to 6.54 per 100,000 population (Rio Grande do Sul, age ≥ 60), while in men, they ranged from 3.78 (Rio de Janeiro, age 15-29) to 37.45 per 100,000 (Rio Grande do Sul, age ≥ 60).

The mean rates were higher in men than women in all age groups and throughout the country (Tables 1 to 4). Except in men aged 15-29 in the states of Maranhão, Paraíba, Bahia, and Rio de Janeiro, the mean suicide rate in male surpassed 5.00 per 100,000.

Considering 224 units of analysis, 21 (9.4%) showed a decreasing trend in suicide rates, 108 (48.2%) were stable, and 95 (42.4%) showed an increasing trend in suicide rates (Tables 1 to 4).

A comparison between projected suicide rates for 2020 versus the WHO Mental Health Action Plan target is presented in Tables 5 and 6. Of the 224 units of analysis, 67% will not meet the WHO target by 2020. Considering only the 21 units of analysis that showed a decreasing trend, 14 will still not meet the WHO target by 2020.

Discussion

Our ecological study showed three main results. First, 90.6% of units of analysis had a stable or increasing trend in suicide rates from 1997 to 2015; if these trends are maintained, 67% of the 224 units of analysis will not achieve a 10% reduction in suicide rates by 2020 as recommended by WHO. Second, there was great variability in mean suicide rate among the Brazilian states. In general, the highest mean suicide rate was found among people aged 60 years and older. However, approximately 85% of suicides occurred in the young and adult population (15-59 years). Furthermore, mean suicide rates in men were always higher than in women, regardless of age group or state of Brazil.

The Brazilian mental health system was reorganized by a psychiatric reform that began in 1978. Since then, mental health care network services have been expanded to provide assistance in the community and to avoid hospitalization. However, only a small part of these services received training for suicide management. Only since 2006 has suicide been recognized as a priority challenge for public health in the country.⁹ In 2017, the Brazilian Ministry of Health, rectifying this concern, designed the 2017-2020 Strategic Action Agenda for Suicide Surveillance and Prevention and Health Promotion in Brazil (Agenda de Ações Estratégicas para a Vigilância e Prevenção do Suicídio e Promoção da Saúde no Brasil 2017-2020),¹⁰ based on the WHO Mental Health Action Plan.³ This document establishes a series of actions to improve the quality of health promotion, suicide surveillance, suicide prevention, and care to victims of attempted suicide and their relatives. Considering the projections of our study, it is essential that these strategies be quickly and effectively implemented throughout Brazil, with special emphasis on vulnerable groups and those with high suicide concentrations.

The variability in suicide rates and trends in Brazilian states evidenced by our study was expected, and had already been observed in previous investigations in the country.^{11,12} The literature has also shown heterogeneity in these rates within the country, which have been explained by cultural, environmental, and socioeconomic differences.¹³⁻¹⁷ It is worth noting that Brazil has one of the world's largest GDPs and one of the highest rates of social and income inequality. In addition, its vast territory, populated by several ethnic groups and cultures from various parts of the world, account for this heterogeneous scenario.

Regardless of the Brazilian state analyzed, our findings have reinforced the magnitude of suicide in men and older adults. According to the WHO, men from richer countries are three times as likely to die by suicide than women, while the male-to-female ratio of suicide deaths in

Table 1 Trends in suicide rates among people aged 15-29, stratified by sex (Brazil, 1997 to 2015)

Region	Female				Male					
	Mean*	β_x^\dagger	R ²	p-value	Trend	Mean*	β_x^\dagger	R ²	p-value	Trend
Brazil	2.22	0.01	0.25	0.029	Increasing	8.23	0.09	0.74	< 0.001	Increasing
North										
Acre	2.89	0.00	0.00	0.956	Stable	11.17	0.56	0.55	0.002	Increasing
Amapá	3.53	0.16	0.34	0.037	Increasing	14.55	0.10	0.01	0.061	Stable
Amazonas	2.47	0.12	0.54	0.002	Increasing	11.93	0.68	0.88	< 0.001	Increasing
Pará	2.13	-0.09	0.37	0.025	Decreasing	5.39	0.14	0.45	0.008	Increasing
Rondônia	3.12	-0.08	0.13	0.129	Stable	9.26	0.08	0.03	0.474	Stable
Roraima	5.68	-0.03	0.00	0.799	Stable	20.06	0.06	0.00	0.841	Stable
Tocantins	2.86	0.11	0.33	0.042	Increasing	9.82	0.43	0.72	< 0.001	Increasing
Northeast										
Aлагоас	1.93	0.05	0.24	0.03	Increasing	6.16	0.06	0.03	0.500	Stable
Bahia	1.10	0.03	0.31	0.014	Increasing	3.88	0.19	0.72	< 0.001	Increasing
Ceará	2.67	0.09	0.68	< 0.001	Increasing	10.69	0.18	0.64	< 0.001	Increasing
Maranhão	1.56	0.04	0.21	0.050	Increasing	4.98	0.39	0.84	< 0.001	Increasing
Paraíba	1.71	0.12	0.39	0.005	Increasing	4.86	0.30	0.76	< 0.001	Increasing
Pernambuco	2.32	-0.04	0.44	0.010	Decreasing	6.35	-0.05	0.13	0.129	Stable
Piauí	3.37	0.19	0.71	< 0.001	Increasing	9.85	0.56	0.83	< 0.001	Increasing
Rio Grande do Norte	1.83	-0.03	0.08	0.231	Stable	6.49	0.13	0.48	0.005	Increasing
Sergipe	2.92	0.12	0.46	0.007	Increasing	7.28	0.32	0.64	< 0.001	Increasing
Center-West										
Distrito Federal	2.50	-0.00	0.00	0.881	Stable	9.23	-0.13	0.12	0.154	Stable
Mato Grosso	3.27	-0.11	0.48	0.005	Decreasing	9.68	0.05	0.02	0.554	Stable
Mato Grosso do Sul	5.44	0.04	0.03	0.461	Stable	17.29	0.39	0.53	0.002	Increasing
Goiás	2.89	-0.03	0.12	0.152	Stable	10.94	0.05	0.03	0.459	Stable
Southeast										
Espírito Santo	1.76	0.05	0.21	0.051	Stable	6.34	-0.12	0.14	0.109	Stable
Minas Gerais	2.22	0.05	0.35	0.032	Increasing	8.64	0.17	0.61	< 0.001	Increasing
Rio de Janeiro	1.34	0.01	0.01	0.700	Stable	3.78	0.00	0.00	0.893	Stable
São Paulo	1.88	0.02	0.45	0.009	Increasing	8.35	0.01	0.38	0.023	Increasing
South										
Paraná	3.08	-0.07	0.35	0.008	Decreasing	11.56	-0.17	0.51	0.001	Decreasing
Santa Catarina	2.71	-0.01	0.01	0.619	Stable	11.11	0.02	0.01	0.655	Stable
Rio Grande do Sul	3.37	-0.07	0.43	0.011	Decreasing	14.27	-0.18	0.44	0.009	Decreasing

* Mean per 100,000 population from 1997 to 2015.

† Annual increase per 100,000 population.

Table 2 Trends in suicide rates among people aged 30-39, stratified by sex (Brazil, 1997 to 2015)

Region	Female				Male					
	Mean*	β_x^\dagger	R ²	p-value	Trend	Mean*	β_x^\dagger	R ²	p-value	Trend
Brazil	2.55	0.03	0.46	0.002	Increasing	11.16	0.09	0.74	< 0.001	Increasing
North										
Acre	3.61	0.03	0.00	0.806	Stable	12.15	0.37	0.14	0.118	Stable
Amapá	1.36	0.00	0.00	0.990	Stable	10.71	0.25	0.31	0.049	Increasing
Amazonas	1.38	0.13	0.39	0.004	Increasing	8.72	0.40	0.79	< 0.001	Increasing
Pará	1.53	0.01	0.01	0.754	Stable	5.67	0.14	0.39	0.019	Increasing
Rondônia	2.82	0.17	0.26	0.025	Increasing	9.90	0.18	0.07	0.282	Stable
Foraíma	4.18	0.16	0.06	0.307	Stable	13.81	-0.30	0.06	0.333	Stable
Tocantins	2.96	0.11	0.08	0.236	Stable	10.49	0.70	0.67	< 0.001	Increasing
Northeast										
Alagoas	1.68	0.03	0.06	0.324	Stable	7.21	0.07	0.04	0.435	Stable
Bahia	1.19	0.04	0.26	0.027	Increasing	5.60	0.25	0.65	< 0.001	Increasing
Ceará	2.91	0.01	0.01	0.723	Stable	14.74	0.24	0.63	< 0.001	Increasing
Maranhão	1.65	0.05	0.12	0.146	Stable	5.90	0.38	0.86	< 0.001	Increasing
Paraíba	1.69	0.07	0.33	0.042	Increasing	8.22	0.47	0.68	< 0.001	Increasing
Pernambuco	2.07	-0.03	0.05	0.336	Stable	8.02	-0.12	0.15	0.096	Stable
Piauí	3.18	0.18	0.56	0.002	Increasing	12.53	0.72	0.66	< 0.001	Increasing
Rio Grande do Norte	2.20	0.03	0.03	0.468	Stable	10.72	0.04	0.01	0.686	Stable
Sergipe	2.59	0.06	0.40	0.017	Increasing	10.94	0.34	0.27	0.022	Increasing
Center-West										
Distrito Federal	2.28	0.02	0.02	0.532	Stable	10.37	-0.03	0.00	0.777	Stable
Mato Grosso	3.44	-0.12	0.16	0.085	Stable	11.90	-0.07	0.03	0.464	Stable
Mato Grosso do Sul	4.10	0.09	0.23	0.040	Increasing	15.49	0.29	0.23	0.040	Increasing
Goiás	3.53	-0.01	0.00	0.831	Stable	12.90	-0.01	0.00	0.933	Stable
Southeast										
Espírito Santo	2.70	0.14	0.58	0.001	Increasing	9.46	-0.04	0.04	0.397	Stable
Minas Gerais	3.12	0.07	0.52	0.003	Increasing	11.91	0.30	0.77	< 0.001	Increasing
Rio de Janeiro	1.84	0.00	0.00	0.822	Stable	5.40	0.02	0.61	0.001	Increasing
São Paulo	2.33	0.03	0.57	0.001	Increasing	10.87	0.11	0.70	< 0.001	Increasing
South										
Paraná	3.44	-0.03	0.03	0.469	Stable	13.57	-0.20	0.47	0.001	Decreasing
Santa Catarina	3.81	0.15	0.60	0.001	Increasing	15.39	-0.28	0.56	0.001	Decreasing
Rio Grande do Sul	4.22	0.03	0.09	0.226	Stable	19.38	-0.21	0.36	0.007	Decreasing

* Mean per 100,000 population from 1997 to 2015.

† Annual increase per 100,000 population.

Table 3 Trends in suicide rates among people aged 40-59, stratified by sex (Brazil, 1997 to 2015)

Region	Female				Male				Trend	
	Mean*	β_x^\dagger	R ²	p-value	Trend	Mean*	β_x^\dagger	R ²		p-value
Brazil	3.03	0.05	0.70	< 0.001	Increasing	11.68	0.04	0.36	0.030	Increasing
North										
Acre	1.72	0.00	0.00	0.956	Stable	8.81	0.35	0.18	0.073	Stable
Amapá	2.08	0.03	0.01	0.753	Stable	9.51	-0.25	0.08	0.231	Stable
Amazonas	1.40	0.09	0.53	0.002	Increasing	6.73	0.11	0.17	0.078	Stable
Pará	1.39	-0.03	0.16	0.088	Stable	5.45	0.08	0.17	0.084	Stable
Rondônia	3.01	-0.03	0.02	0.566	Stable	9.69	-0.09	0.02	0.533	Stable
Roraima	2.12	0.03	0.00	0.824	Stable	12.24	-0.00	0.00	0.996	Stable
Tocantins	3.62	0.10	0.33	0.04	Increasing	11.83	0.28	0.37	0.024	Increasing
Northeast										
Aлагоас	1.79	0.05	0.34	0.037	Increasing	7.90	0.14	0.16	0.085	Stable
Bahia	1.39	0.06	0.44	0.002	Increasing	6.69	0.25	0.85	< 0.001	Increasing
Ceará	3.47	0.04	0.07	0.265	Stable	14.46	0.32	0.52	0.003	Increasing
Maranhão	1.47	0.09	0.65	< 0.001	Increasing	5.94	0.29	0.71	< 0.001	Increasing
Paraíba	2.11	0.13	0.50	0.004	Increasing	8.44	0.52	0.76	< 0.001	Increasing
Pernambuco	2.40	0.01	0.02	0.604	Stable	9.17	-0.11	0.22	0.041	Decreasing
Piauí	3.48	0.18	0.51	0.001	Increasing	12.83	0.82	0.80	< 0.001	Increasing
Rio Grande do Norte	2.48	0.02	0.01	0.706	Stable	11.88	0.26	0.35	0.030	Increasing
Sergipe	2.96	0.09	0.15	0.106	Stable	10.39	0.38	0.58	0.001	Increasing
Center-West										
Distrito Federal	3.56	0.06	0.07	0.271	Stable	9.45	0.09	0.07	0.269	Stable
Mato Grosso	3.46	0.02	0.01	0.750	Stable	12.82	-0.21	0.17	0.080	Stable
Mato Grosso do Sul	3.42	-0.05	0.10	0.181	Stable	14.25	0.08	0.03	0.459	Stable
Goiás	3.88	0.04	0.08	0.250	Stable	13.85	-0.10	0.05	0.378	Stable
Southeast										
Espírito Santo	3.62	0.15	0.50	0.004	Increasing	10.67	0.05	0.05	0.378	Stable
Minas Gerais	3.46	0.17	0.81	< 0.001	Increasing	12.17	0.38	0.79	< 0.001	Increasing
Rio de Janeiro	2.08	0.01	0.03	0.513	Stable	6.09	0.03	0.03	0.484	Stable
São Paulo	2.84	0.03	0.19	0.066	Stable	10.25	-0.05	0.65	< 0.001	Decreasing
South										
Paraná	3.56	-0.01	0.01	0.751	Stable	14.76	-0.24	0.73	< 0.001	Decreasing
Santa Catarina	5.38	0.13	0.45	0.008	Increasing	21.24	-0.26	0.58	0.001	Decreasing
Rio Grande do Sul	5.94	0.03	0.31	0.049	Increasing	26.34	-0.35	0.61	< 0.001	Decreasing

* Mean per 100,000 population from 1997 to 2015.

† Annual increase per 100,000 population.

Table 4 Trends in suicide rates among people aged ≥ 60 years, stratified by sex (Brazil, 1997 to 2015)

Region	Female				Male					
	Mean*	β_x^\dagger	R ²	p-value	Trend	Mean*	β_x^\dagger	R ²	p-value	Trend
Brazil	2.57	0.02	0.30	0.015	Increasing	13.84	0.03	0.07	0.285	Stable
North										
Acre	0.89	-0.01	0.00	0.897	Stable	8.86	0.22	0.04	0.424	Stable
Amapá	1.46	-0.18	0.08	0.234	Stable	10.44	0.28	0.02	0.572	Stable
Amazonas	1.18	0.08	0.16	0.091	Stable	6.77	0.20	0.16	0.091	Stable
Pará	0.96	0.03	0.07	0.279	Stable	6.22	0.13	0.17	0.080	Stable
Rondônia	1.84	-0.00	0.00	0.982	Stable	10.02	-0.09	0.01	0.732	Stable
Roraima	2.71	0.31	0.10	0.196	Stable	14.25	-0.38	0.04	0.429	Stable
Tocantins	3.11	0.20	0.24	0.033	Increasing	14.75	0.75	0.33	0.010	Increasing
Northeast										
Alagoas	1.60	0.05	0.07	0.273	Stable	8.96	0.30	0.24	0.035	Increasing
Bahia	1.22	0.06	0.29	0.017	Increasing	8.05	0.34	0.55	0.002	Increasing
Ceará	2.76	0.07	0.32	0.044	Increasing	14.97	0.44	0.62	0.001	Increasing
Maranhão	1.24	0.07	0.26	0.024	Increasing	6.49	0.61	0.81	< 0.001	Increasing
Paraíba	2.24	0.08	0.14	0.121	Stable	11.18	0.69	0.72	< 0.001	Increasing
Pernambuco	2.53	-0.07	0.54	0.002	Decreasing	11.37	-0.05	0.02	0.547	Stable
Piauí	3.74	0.27	0.54	0.002	Increasing	16.63	1.13	0.84	< 0.001	Increasing
Rio Grande do Norte	2.97	0.05	0.04	0.438	Stable	14.34	0.051	0.46	0.008	Increasing
Sergipe	3.14	0.16	0.24	0.034	Increasing	12.70	0.64	0.43	0.011	Increasing
Center-West										
Distrito Federal	2.11	0.02	0.01	0.727	Stable	12.09	-0.12	0.02	0.570	Stable
Mato Grosso	2.86	-0.03	0.01	0.691	Stable	16.52	-0.03	0.00	0.858	Stable
Mato Grosso do Sul	3.80	-0.04	0.02	0.553	Stable	21.23	-0.62	0.41	0.015	Decreasing
Goiás	2.99	-0.01	0.00	0.896	Stable	18.66	0.06	0.02	0.532	Stable
Southeast										
Espírito Santo	2.26	0.02	0.01	0.753	Stable	11.17	-0.00	0.00	0.976	Stable
Minas Gerais	2.08	0.11	0.68	< 0.001	Increasing	11.06	0.32	0.55	< 0.001	Increasing
Rio de Janeiro	1.63	0.01	0.01	0.730	Stable	8.06	-0.12	0.15	0.102	Stable
São Paulo	2.25	-0.00	0.00	0.903	Stable	11.30	-0.17	0.51	0.003	Decreasing
South										
Paraná	2.63	-0.04	0.12	0.149	Stable	16.91	-0.45	0.55	0.002	Decreasing
Santa Catarina	5.33	0.06	0.07	0.265	Stable	30.03	-0.53	0.56	0.001	Decreasing
Rio Grande do Sul	6.54	-0.07	0.13	0.130	Stable	37.45	-0.59	0.59	0.001	Decreasing

* Mean per 100,000 population from 1997 to 2015.

† Annual increase per 100,000 population.

Table 5 Comparison between projected suicide rates (per 100,000 population) for 2020* and the World Health Organization (WHO) Mental Health Action Plan target† for women, stratified by age group

Region	15-29 years		30-39 years		40-59 years		≥ 60 years	
	Projection 2020	WHO 2020	Projection 2020	WHO 2020	Projection 2020	WHO 2020	Projection 2020	WHO 2020
Brazil	2.36	2.02	2.97	2.24	3.73	3.19	2.85	2.80
North								
Acre	2.89	4.93	3.61	3.15	1.72	0.00	0.09	0.00
Amapá	0.83	2.54	1.36	0.00	2.08	3.07	1.46	0.00
Amazonas	7.57	4.24	3.20	3.39	6.11	0.56	1.18	2.39
Pará	2.57	1.53	1.53	1.33	1.39	1.27	0.96	1.57
Rondônia	3.12	1.50	5.20	4.48	3.01	2.01	1.84	0.00
Roraima	5.68	5.09	4.18	5.03	2.12	2.23	2.71	7.61
Tocantins	2.79	3.54	2.96	2.35	0.00	1.30	5.91	1.53
Northeast								
Alagoas	2.63	1.80	1.68	1.02	4.02	2.40	1.60	2.24
Bahia	1.52	1.13	1.52	1.34	2.23	1.95	2.06	2.46
Ceará	2.36	2.69	2.91	2.49	3.47	3.35	5.36	3.76
Maranhão	2.12	1.80	1.65	0.52	2.73	1.95	2.22	2.45
Paraíba	3.39	2.10	0.96	2.24	3.80	2.92	2.24	2.90
Pernambuco	0.13	1.64	2.07	0.83	2.40	1.89	4.84	1.81
Piauí	2.75	3.63	2.40	3.10	6.00	1.61	4.09	7.79
Rio Grande do Norte	1.83	1.00	2.20	1.68	2.48	2.64	2.97	3.18
Sergipe	1.30	3.26	0.00	1.99	2.96	4.23	5.38	2.52
Center-West								
Distrito Federal	2.50	2.46	2.28	3.65	3.56	2.60	2.11	1.30
Mato Grosso	0.00	1.93	1.76	2.11	3.46	5.69	2.86	2.79
Mato Grosso do Sul	5.44	4.89	3.44	5.74	3.42	3.59	3.80	3.33
Goiás	2.89	2.36	3.53	2.33	3.88	4.37	2.99	3.36
Southeast								
Espírito Santo	1.76	0.74	6.18	4.02	4.11	4.08	2.26	3.60
Minas Gerais	1.14	2.05	2.42	2.34	5.84	4.19	5.43	2.76
Rio de Janeiro	1.34	1.08	1.84	1.72	2.08	1.91	1.63	1.36
São Paulo	3.95	1.96	0.15	2.05	2.84	2.94	2.25	2.07
South								
Paraná	2.03	1.78	3.44	2.40	3.56	3.52	2.63	2.68
Santa Catarina	2.71	1.70	7.58	3.67	10.45	6.75	5.33	5.70
Rio Grande do Sul	4.05	3.17	4.22	3.87	7.92	5.77	6.54	6.23

* Using polynomial regression models and a 1997-2015 time series.

† WHO Mental Health Action Plan target: a 10% reduction in suicide rate by 2020, using 2013-year rates as baseline.

Table 6 Comparison between projected suicide rates (per 100,000 population) for 2020* and the World Health Organization (WHO) Mental Health Action Plan target† for men, stratified by age group

Region	15-29 years		30-39 years		40-59 years		≥ 60 years	
	Projection 2020	WHO 2020	Projection 2020	WHO 2020	Projection 2020	WHO 2020	Projection 2020	WHO 2020
Brazil	9.49	7.99	13.49	10.69	13.92	10.87	13.84	12.49
North								
Acre	17.27	13.68	12.15	15.44	8.81	8.37	8.86	0.00
Amapá	14.55	19.15	25.81	11.42	9.51	8.43	10.44	15.36
Amazonas	29.77	17.11	22.52	11.35	6.73	5.97	6.77	5.21
Pará	8.97	5.34	10.8	6.77	5.45	5.72	6.22	7.39
Rorônia	9.26	9.35	9.90	13.16	9.69	8.59	10.02	7.18
Roraima	20.06	13.54	13.81	12.29	12.24	14.03	14.25	6.89
Tocantins	10.82	10.71	10.28	15.81	7.59	13.57	10.27	16.37
Northeast								
Alagoas	6.16	8.84	7.21	8.62	7.90	9.19	13.16	13.01
Bahia	4.81	3.87	7.49	6.37	8.57	7.67	11.07	11.99
Ceará	6.56	11.11	8.11	14.41	12.21	14.63	14.56	17.84
Maranhão	12.16	6.52	14.66	7.96	10.00	7.79	18.30	10.61
Paraíba	9.06	6.02	14.8	10.92	17.35	12.92	15.74	14.58
Pernambuco	6.35	5.02	8.02	9.55	7.63	7.50	11.37	10.39
Piauí	14.46	12.19	9.97	12.17	19.46	17.23	32.45	18.48
Rio Grande do Norte	3.46	6.48	10.72	9.12	10.41	11.54	14.85	13.21
Sergipe	11.76	8.68	15.70	9.80	7.38	12.49	16.55	14.26
Center-West								
Distrito Federal	9.23	8.96	10.37	8.91	9.45	9.23	12.09	8.86
Mato Grosso	9.68	9.41	11.90	8.76	12.82	10.62	16.52	14.86
Mato Grosso do Sul	16.07	17.45	19.55	15.34	14.25	15.34	15.80	15.77
Goiás	10.94	10.83	12.90	11.61	13.85	13.86	18.66	14.94
Southeast								
Espírito Santo	6.34	4.10	9.46	8.43	10.67	9.67	11.17	4.85
Minas Gerais	9.36	8.38	12.72	10.57	15.95	11.73	15.54	11.84
Rio de Janeiro	3.78	2.73	10.75	6.00	6.09	5.03	8.06	6.03
São Paulo	11.76	8.02	18.92	12.11	14.60	9.40	10.53	8.62
South								
Paraná	9.18	10.02	10.77	11.75	18.17	12.28	20.65	12.71
Santa Catarina	11.11	9.47	18.03	14.36	25.95	18.06	40.79	26.32
Rio Grande do Sul	10.00	10.69	16.44	16.92	21.44	22.78	30.90	29.19

* Using polynomial regression models and a 1997-2015 time series.

† WHO Mental Health Action Plan target: a 10% reduction in suicide rate by 2020, using 2013-year rates as baseline.

low- and middle-income countries is around 1.5. In addition, the suicide rate is highest in people aged 70 years and over, regardless of gender.¹

Finally, the high absolute number of suicides that occurred in the young and adult population during the period of analysis is worrisome. It bears stressing that deaths in this age group have major economic and social costs,¹⁸ besides reflecting lower quality of life in the population. A previous Brazilian study highlighted the importance and impact of external causes of premature death and disability among the population and found that suicide was the sixth leading external cause of years of life lost to death or disability.¹⁹

Although ecological studies are useful for generating hypotheses, we acknowledge that the main limitation of our study was the possibility of ecological bias, that is, the failure in reasoning that arises when an inference is made about an individual based on aggregate data for a group. The specialized literature suggests some strategies to avoid this kind of bias, one of which is the use of smaller units of analysis to make groups more homogeneous in relation to exposures.²⁰ Thus, we chose to stratify these rates by state, gender, and age groups, given the massive size of Brazil and the available official data on suicide. Furthermore, once this stratification was done, it gave us mathematical support to dismiss the standardized suicide ratio and use crude rates instead.

Another important limitation of our study was the use of data on suicide from a secondary database; specifically, the Brazilian Ministry of Health SIM. Although the coverage and quality of these data are regarded as satisfactory, underreporting and misclassification are known to occur, and tend to lead to underestimation of suicide rates, particularly in developing regions.²¹ However, a review indicates that underestimation is not sufficient to bias results in this type of analysis.²²

The main strength of our study was the use of panel data. In settings with areas and populations as large as that of Brazil, an ecological time-series approach can quickly identify vulnerable groups to which resources should be allocated as a priority, as well as groups with low suicide rates, which can provide insights into best practices.²³

Although the Brazilian scenario is alarming, we believe that suicide can be prevented by public health strategies and social policies.²⁴ Therefore, our study contributes with well-founded data nationwide that strengthens the need for rapid implementation of actions for health promotion and prevention of this phenomenon, as provided for in the 2017-2020 Strategic Action Agenda for Suicide Surveillance and Prevention and Health Promotion in Brazil.

Disclosure

The authors report no conflicts of interest.

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