



## Influence of the global crisis of 2008 and the Brazilian political oscillations of 2014 on suicide rates: An analysis of the period from 2002 to 2017

Eliane Maria Spiecker<sup>a,\*</sup>, Patrícia Costa Mincoff Barbanti<sup>a</sup>, Paulo Acácio Egger<sup>a</sup>, Maria Dalva de Barros Carvalho<sup>a</sup>, Sandra Marisa Peloso<sup>a</sup>, Marta Rovey de Souza<sup>b</sup>, Luciano de Andrade<sup>a</sup>, Catherine A. Staton<sup>c,d</sup>, Marcia Lorena Alves<sup>e</sup>, Eniuce Menezes de Souza<sup>e,f</sup>, Raíssa Bocchi Pedroso<sup>a</sup>, João Ricardo Nickenig Vissoci<sup>a,c,d</sup>

<sup>a</sup> Postgraduate Program in Health Sciences, State University of Maringá, 5790 Colombo Ave, 87020-900, Maringá, Paraná, Brazil

<sup>b</sup> Department of Public Health, Federal University of Goiás, Esperança Ave, 74690-900, Goiânia, GO, Brazil

<sup>c</sup> Duke Global Health Institute, Duke University, 310 Trent Dr, 27710, Durham, NC, USA

<sup>d</sup> Duke Division of Emergency Medicine, Department of Surgery, Duke University Medical Center, 2301 Erwin Rd, 27707, Durham, NC, USA

<sup>e</sup> Postgraduate Program in Biostatistics, State University of Maringá, 5790 Colombo Ave, 87020-900, Maringá, Parana, Brazil

<sup>f</sup> Department of Statistics, State University of Maringá, 5790 Colombo Ave, 87020-900, Maringá, Parana, Brazil

### ABSTRACT

Global suicide rates have increased in recent decades becoming a serious social and public health problem. In Brazil, rates have been increasing annually. We aimed to analyze the correlation between suicide mortality rates and global economic and political crisis periods of 2008 and 2014 in Brazil. The analysis of suicide mortality in Brazil was done using a time-series segmented linear regression model that estimated the trend of rates over time. To obtain the model, changes in the trend of both abrupt and gradual suicide rates were investigated. The results indicate statistically significant changes showing an upward trend of suicide rates during the world economic crisis (2008-2013) and during the economic and political crisis in Brazil (2014-2017) compared to previous periods, especially at the extremes of schooling (3 < years and > 8 years). Among white and parda, there were significant trend rates increases in both periods and in different regions. In the Northeast and South regions, we observed a significant increase in the trend rate for males after the Brazilian economic and political crisis (2014 to 2017). We can conclude that the national suicide rates were influenced by the economic and political instability that our country has been going through since 2008, affecting each region differently. Further studies are needed to explore the reasons for interregional differences and the relation of suicide with unemployment rates and possible economic predictors.

### Introduction

In recent decades, global suicide rates have risen significantly so that every 40 s a person takes their own life (World Health Organization, 2014). Suicide has become a serious social and public health problem and is a leading cause of death in both high and low, income countries (Machado, Rasella, & dos Santos, 2015; Rukundo, Mishara, & Kinyanda, 2016). Although Brazil does not have a high suicide mortality rates as other countries in the world, its rates has been increasing over the last few years (Alicandro et al., 2019; Ministry of Health - Brazil, 2017). Suicide mortality represents the third leading cause of death from injuries in Brazil (Reichenheim et al., 2011).

Economic downturns have long been associated with increased rates of suicide. For example, the 1997 and 1998 Asian economic recession was associated with an increase in suicide rates in Japan, Hong Kong,

and South Korea (Chang, Gunnell, Sterne, Lu, & Cheng, 2009). Similarly, the 2008 global crisis was followed by an increase in suicide incidence in many parts of the world, reversing an earlier downward trend that occurred between 2001 and 2007 (Chang, Stuckler, Yip, & Gunnell, 2013). Other recessions in Spain and England were also associated with increased suicide rates (Barr, Taylor-Robinson, Scott-Samuel, McKee, & Stuckler, 2012; Lopez Bernal, Gasparrini, Artundo, & McKee, 2013).

Brazil has recently faced a similar economic and political crisis along with a swift turn in the government ideology towards austerity measures. Brazil was not strongly affected by the 2008 economic downturn, but the political crisis of 2014 had a strong impact on both the economy and investments (Mortozza & Piqueira, 2017). The new public policies that have been launched since 2016 to deal with the political crisis have reduced social investment resources. The austerity measures and budgets cuts adopted by Brazil have not affected society equally. As this is

\* Corresponding author.

E-mail address: [elianespiecker@gmail.com](mailto:elianespiecker@gmail.com) (E.M. Spiecker).

<https://doi.org/10.1016/j.ssmph.2021.100754>

Received 23 September 2020; Received in revised form 31 December 2020; Accepted 7 February 2021

Available online 13 February 2021

2352-8273/© 2021 The Author(s).

Published by Elsevier Ltd.

This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

not a momentary crisis, the freezing of the public spending for a long time has led to the weakening of social policies (Santos & Vieira, 2018). Workers had lost purchasing power, and inflation accelerated again, causing a reduction in household consumption, and austerity has expanded this situation (Cunha & Santos, 2014; Machado, Pescarini, Araújo, & Barreto, 2019). In addition, the fall in the profit margin caused by the price control policy (a measure taken by the government to prevent the price to increase in order to keep inflation within the established target), raised unemployment rates, which reached an average of 8.7% in 2015, the highest since 2010 (Cunha & Santos, 2014; Houle & Light, 2017; Machado et al., 2019).

Potential reasons for the increasing wave of suicides following an economic crisis could be related to mental health impacting factors that occur in recession times, such as job loss, debts, relationship tensions, reduction of spends by the government, among others (Coope et al., 2014; Machado et al., 2019). Many studies have shown that unemployment and cut in the programs of social protection influences suicide rates, and that job and social security is important to lessen the impact on suicide (Alves, Machado, & Barreto, 2019; Barr et al., 2012; Chang et al., 2009; Classen & Dunn, 2012; Machado et al., 2015; Mortoza & Piqueira, 2017). It is known that mental and behavioural disorders and chronic pain, associated with alcohol and drug abuse, represents the main risk to suicide, however, associated with some factors, such as unemployment duration and governmental austerity measures, the risk of suicide is enhanced (Chesney, Goodwin, & Fazel, 2014; Classen & Dunn, 2012; Hassett, Aquino, & Ilgen, 2014; Kerr, Subbaraman, & Ye, 2011; Kim, 2016; Mortoza & Piqueira, 2017; Stickley et al., 2020). Of 675 people who committed suicide in a US urban area between 1997 and 2000, in more than two-thirds of the suicide-related deaths, multiple stressors seemed to contribute - particularly the economic crisis-related stress along with relationship difficulties (Stack & Wasserman, 2007). These factors can still be intensified by government austerity measures such as cuts in social spending and healthcare budgets (Karanikolos et al., 2013).

In addition, most suicide studies following economic crises were conducted in high-income countries, while most suicide deaths occur in low-income countries (Hawton & Heeringen, 2009). Similar to other developing countries, due to economic fluctuations, Brazil would be an excellent setting to investigate socioeconomic risk factors for suicide. Since the crisis of 2008, no studies have reported suicide mortality trends caused by the world economic crisis (2008) and the Brazilian economic and political crisis (2014). This study aims to analyze the association of suicide mortality rates with periods related to global economic recession and the political crisis in Brazil from 2002 to 2017.

## Method

### Design and place of study

This is a descriptive cross-sectional study, using secondary population-based data from January 1, 2002 to December 31, 2017. The research was conducted in Brazil, a country with an area of 8.515.767,049 km<sup>2</sup> with an estimated population of 207.660 million inhabitants in 2017 (Brazilian Institute of Geography and Statistics, 2017).

### Source/data collection

Suicide mortality data per Brazilian region were collected from the Mortality Information System (SIM) (Department of the Unified Health System, 2018) and analyzed with the R software. With the use of SIM, the mortality data in the country are regularly obtained to monitor, plan and evaluate public health management (Department of the Unified Health System, 2018). The codes used in data collection were X60-X84 (ICD-10).

The variables analyzed were sex (male and female), age group

(15–29; 30–44; 45–59 and 60–69), race/color (white, black, parda\*, yellow-skinned\* and indigenous) and education ( $\leq 3$  years, 4–7 years of study and  $\geq 8$  years). While the information about the level of education was collected, we found a high underreporting number. This information did not exist for 42.57% of cases (3.289 deaths) in 2002. Underreporting about the level of education has always been high in Brazil. However, the failure to fill this information has been reducing in the last few years. During the period from 2002 to 2017, it had a reduction of 21.87% of failure to fill in the information on the educational level, although 20.7% of the statements still have this data ignored in 2017. The first two were obtained from the IT department of the Brazilian Unified Health System (DATASUS) in sociodemographic data of the resident population (Department of the Unified Health System, 2018), and the last two were collected from the Historical and Statistical Series of the Brazilian Institute of Geography and Statistics (Brazilian Institute of Geography and Statistics, 2018).

### Crisis periods

Two crisis periods were chosen to assess the change in suicide rates trends. These crisis periods were selected taking into account the 2008 global economic downturn, as well as the Brazilian GDP performance and unemployment rates for the following period.

The year 2008 was chosen as the first crisis period, because it was when the crisis in the American housing market quickly became an international financial crisis (Carcanholo, Pinto, Filgueiras, & Gonçalves, 2008, pp. 197–234). Then, 2014 was chosen as the second crisis period because since then, Brazil has faced economic recession and political instability, with many economic indicators being affected, such as income, unemployment and inflation (Gimenez, 2017; Paula & Pires, 2017). The unemployment rate for example was 6.5% in 2014, reaching 12% at the end of 2016 (Gimenez, 2017). Gimenez (2017) describes there is a symbiosis between economic recession and the political crisis, which reinforces the choice of these two periods as crisis periods.

### Data analysis

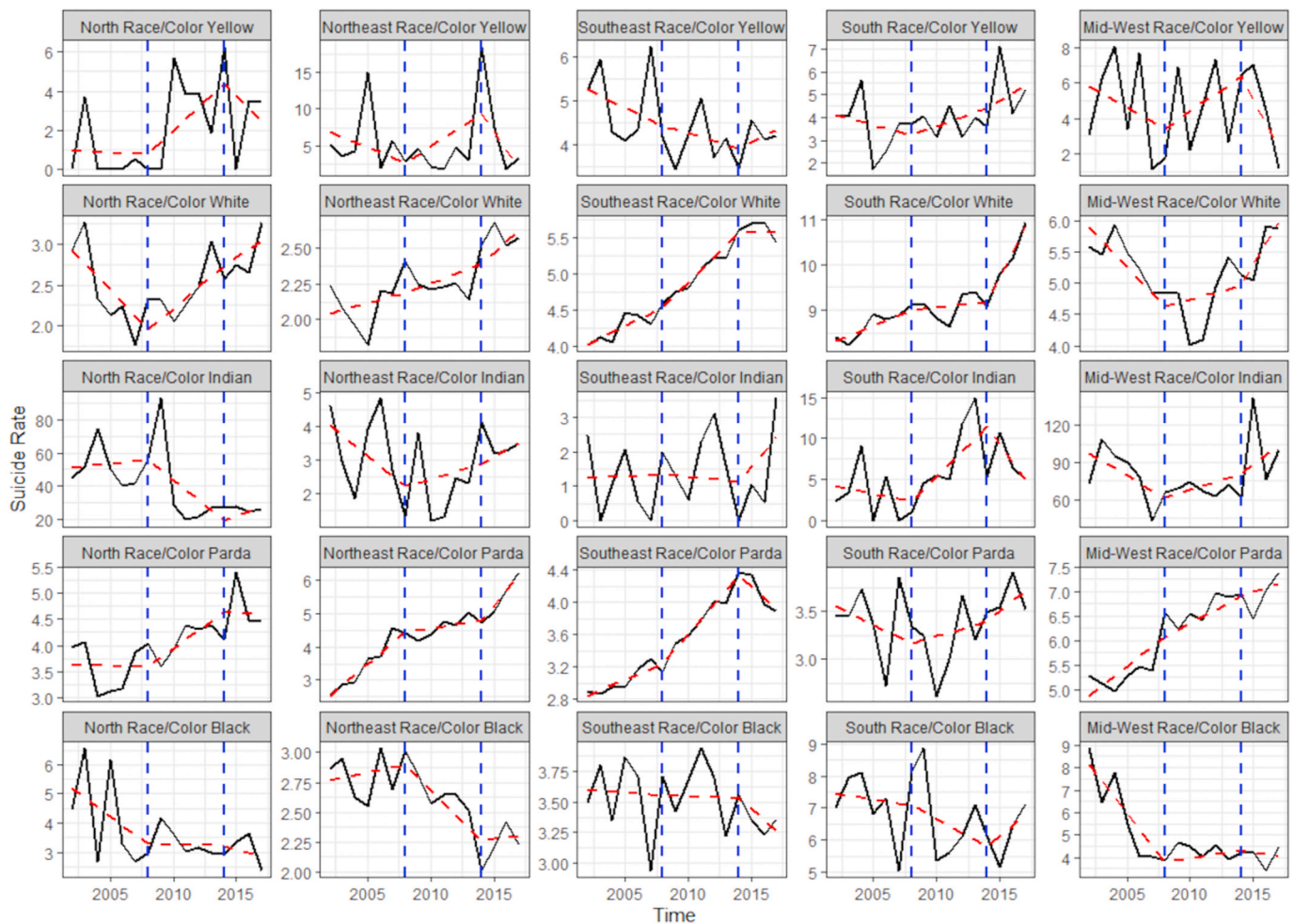
The Brazilian suicide mortality analysis was performed using a time-series segmented linear regression model. The model estimated the trend of suicide rates over time (Chatfield, 2003; Cryer & Chan, 2008; Moretton & Tolo, 2004). The global economic downturn and the political instability in the country, which occurred in 2008 and 2014, respectively, were considered as interventions, allowing the analysis of the impact these factors had on suicide rates.

In the model construction, parameters ( $\beta_2$  and  $\beta_3$ ) were inserted to estimate possible changes in suicide rates at the intervention period through the following equation:

$$Y_t = \beta_0 + \beta_1 t (2002-2017) + \beta_2 t (2008-2017) + \beta_3 t (2014-2017) + \varepsilon_t \quad (1).$$

- where:
- $t(x)$ : indicates a year sequence of period  $x$ ;
  - $Y_t$ : is the suicide rate/year ( $t$ ) according to a variable and category;
  - $\beta_0$ : is the estimated average suicide rate at baseline in 2002;
  - $\beta_1$ : is the linear trend from 2002 to 2007, prior to the economic downturn;
  - $\beta_2$ : estimates the change in inclination or in suicide rates trend from 2008 to 2013 compared to the trend in the previous period (from 2002 to 2007);
  - $\beta_3$ : estimates the change in the suicide rate trend following the political crisis, the last series period (2014–2017);
  - $\varepsilon_t$ : represents the random variability not explained by the model and should be normally distributed and not correlated.

To interpret the trend of rates after the economic downturn (2008–2013) in the model represented in equation (1), the change in the trend estimated by  $\beta_2$  needs to be added to the trend estimated in the previous period, that is  $\beta_1 + \beta_2$ . Similarly, following the political crisis, the resulting trend or the annual average change is represented by  $\beta_1 +$



**Fig. 1.** Trend change in the Brazilian suicide rates considering race/color and region after the global economic downturn (2008–2013) and the Brazilian political crisis (2014–2017). Note: continuous dark line: observed series; dashed red line: estimated model; vertical dashed blue lines: 2008 economic downturn; 2014 political crisis. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

$\beta_2 + \beta_3$ .

After estimating trends, the assumption of independence in the residuals was verified from correlograms and the Durbin-Watson test (Durbin & Watson, 1951). For the series in which the estimated errors showed significant autocorrelation, the Cochrane-Orcutt iterative procedure could be applied to the model adequacy (Cochrane & Orcutt, 1949). From the estimated trend and its respective standard error, we verified the existence or change of a statistically significant increasing or decreasing trend ( $p < 0.005$  with CI = 95%).

R language, version 3.2.3, was used to generate time series, estimate models and perform analysis. Basic stats and lmtest packages were used to carry out the implementations. The research project was waived approval by the Standing Committee on Ethics in Research Involving Human Beings (COPEP) of the State University of Maringá, Official Letter number 28/2018, in accordance with Resolution number 466/2012 and Resolution number 510/2016 from the National Research Council/MS.

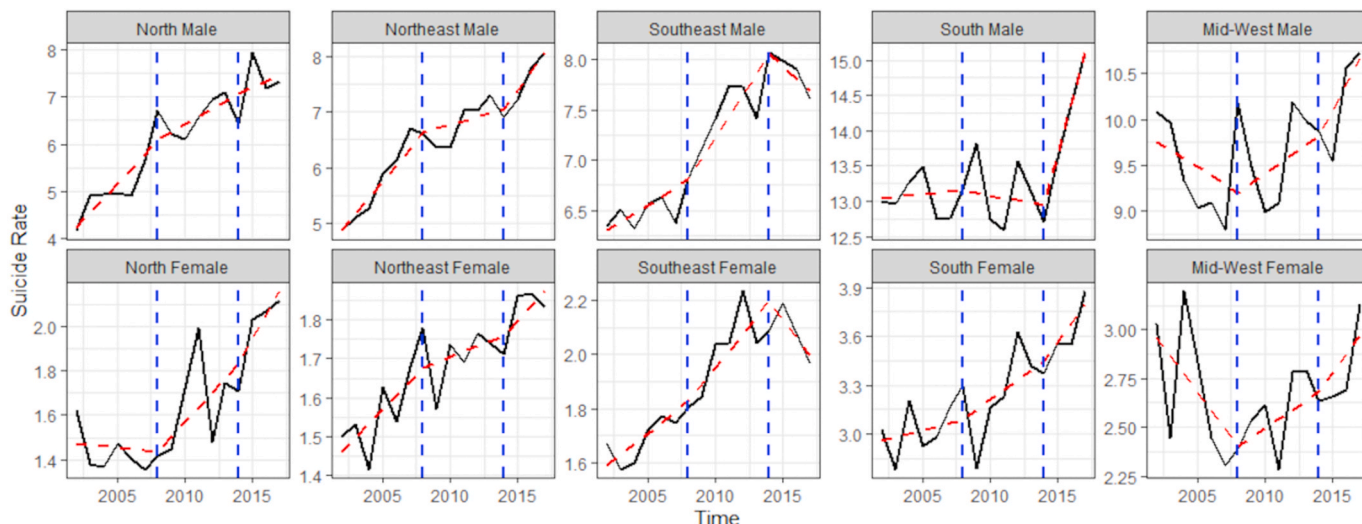
**Results**

In Brazil, from 2002 to 2017, 154.276 suicide deaths were recorded, with an annual average of 9.642 deaths. Between 2002 and 2007, the annual average suicide rate was 6.08/100.000 inhabitants (SD + 0.25); 6.66 (SD + 0.32) from 2008 to 2013 and 7.45 (SD + 0.53) from 2014 to 2017.

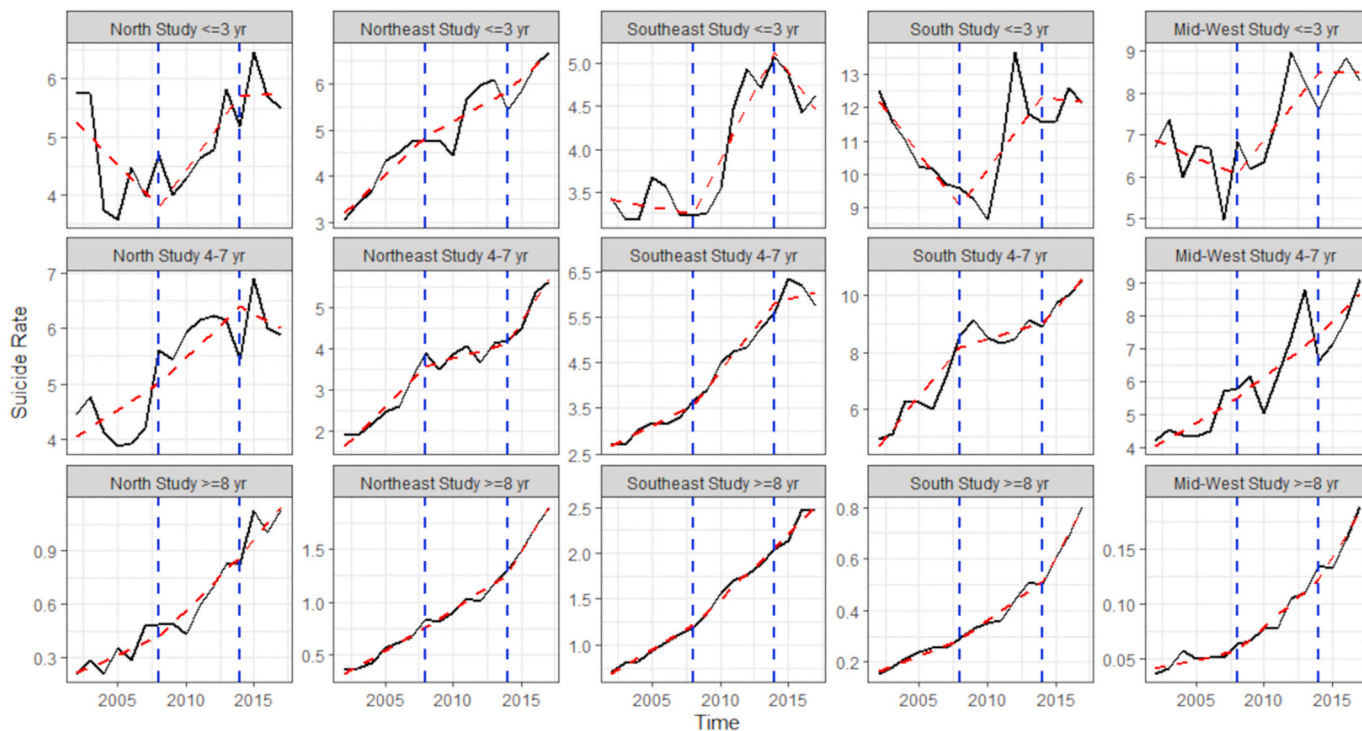
Suicide deaths were male predominance of 78.84%. Regarding age

distribution, the range between 30 and 44 years old had the highest number of suicides 47.724 (30.93%), followed by 15–29 with 44.948 (29.13%) and 45 to 59 with 35.341 (22.91%).

Fig. 1 shows trend change in the Brazilian suicide rates considering race/color and region after the global economic downturn (2008–2013) and the Brazilian political crisis (2014–2017). In the analysis regarding race, the curves show that for white and parada population, there was a higher occurrence of trend change, in both periods in different regions. Among the white and parada population there was an increasing trend in the suicide rates from 2002 to 2007, which increased even more after the global economic downturn (2008–2013) CI95% = [0.010; 0.163 and CI95% = 0.057; 0.174] respectively in the Southeast region. On the other hand, the Southeast region showed a statistically significant downward trend among white CI95% = [-0.302; -0.045] and parada population CI95% = [-0.425; -0.228] in the period of economic and political crisis (2014–2017) compared to the previous period. In comparison with the period from 2002 to 2007, we observed a statistically significant upward trend of the suicide rate, among the white population 95% CI = [0.096; 0.479] in the North region. After the period of decreasing trends in suicide rates from 2002 to 2007, there was a statistically significant trends increase among white CI95% = [0.014; 0.519] after the global economic downturn (2008–2013) in the Midwest region. The suicide rates showed a statistically significant upward trend among white population CI95% = [0.309; 0.758] in the South region. The visual analysis of the curves showed a change in suicide rates resulted in a decreasing trend among parada population CI95% = [-0.397; -0.126], in



**Fig. 2.** Trend change in the Brazilian suicide rates considering sex and region after the global economic downturn (2008–2013) and the Brazilian political crisis (2014–2017). Note: continuous dark line: observed series; dashed red line: estimated model; vertical dashed blue lines: 2008 economic downturn; 2014 political crisis.



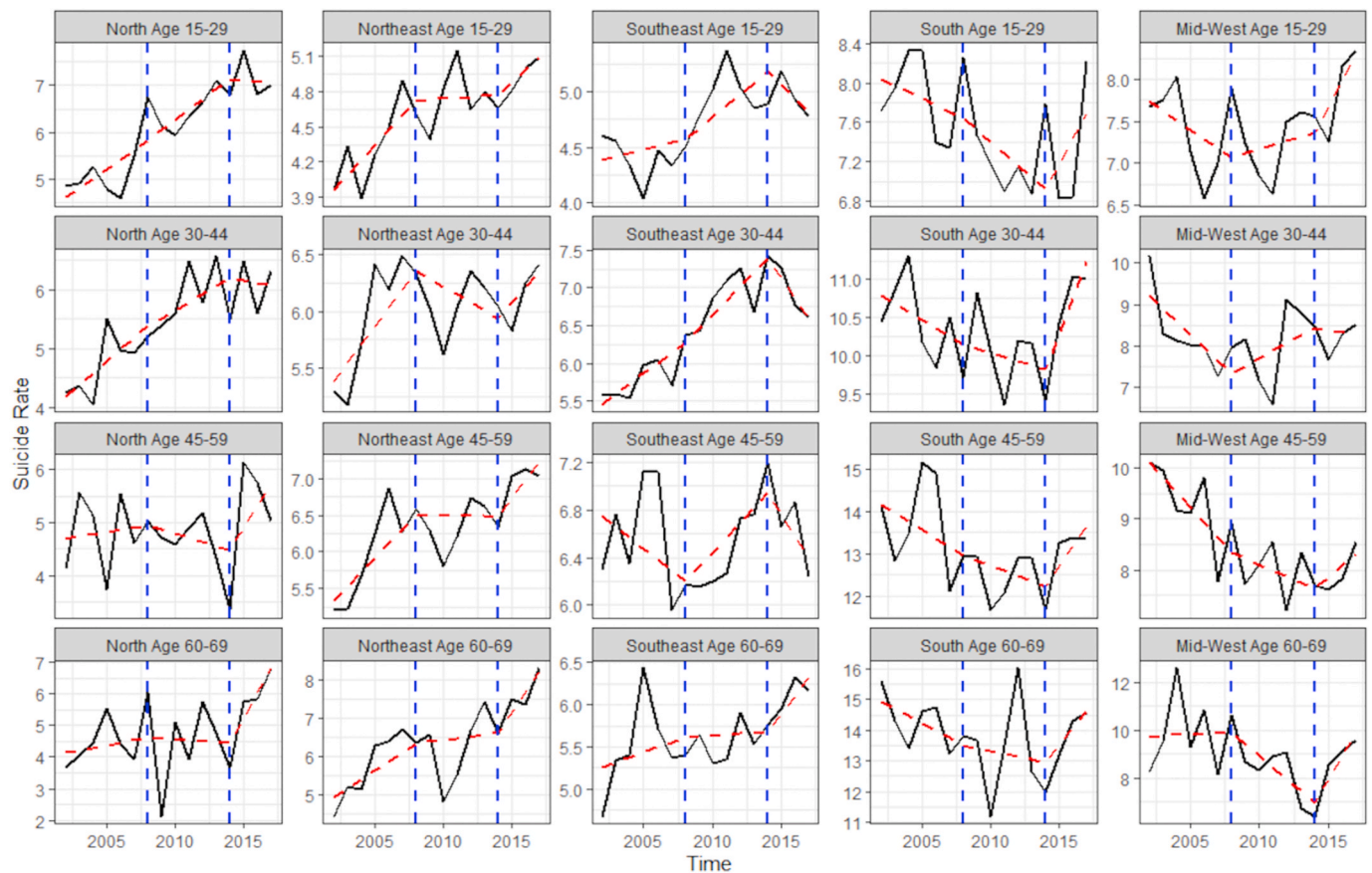
**Fig. 3.** Trend change in the Brazilian suicide rates considering the level of education and region after the global economic downturn (2008–2013) and the Brazilian political crisis (2014–2017). Note: continuous dark line: observed series; dashed red line: estimated model; vertical dashed blue lines: 2008 economic downturn; 2014 political crisis.

the Northeast region, when compared with 2008–2013, with the previous period. However, after 2014, we observed that suicide rates showed a statistically significant upward trend among *parda* population  $CI_{95\%} = [0.169; 0.622]$  in these regions.

In Fig. 2, it is shown the trend change in the Brazilian suicide rates considering sex and regions. In the Northeastern region, there was an increasing trend in the suicide rates from 2002 to 2007 among male, which decreased after the global economic downturn (2008–2013)  $CI_{95\%} = [-0.369; -0.072]$ . However, from 2014 to 2017, we observed that suicide rates increasing went back, showing upward trend in the Northeast region, among males  $CI_{95\%} = [0.013; 0.514]$ . On the other

hand, in the South region, when comparing 2014 to 2017, the previous periods (2002–2007 and 2008 to 2013), we observed that suicide rates shows a statistically significant and accented upward trend among males  $CI_{95\%} = [0.370; 1189]$ . The statistically significant downward trend was observed after 2014 to 2017 in the Southeast region in both sex  $CI_{95\%} = [-0.552; -0.117]$ ,  $CI_{95\%} = [-0.21; -0.043]$  respectively. The visual analysis of the curves demonstrated a stability in growth mainly among women.

In Fig. 3, it shows the trend change in the Brazilian suicide rates considering the level of education and region after the global economic downturn of 2008 and the Brazilian political crisis in 2014.



**Fig. 4.** Trend change in the Brazilian suicide rates considering age and region after the global economic downturn (2008–2013) and the Brazilian political crisis (2014–2017). Note: continuous dark line: observed series; dashed red line: estimated model; vertical dashed blue lines: 2008 economic downturn; 2014 political crisis. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Firstly, it is important to emphasize that in the period studied, 31,62% of the information about level education data was ignored.

While analyzing the education in the period of 2008–2013, the greatest upward trends of suicide rate were observed in the regions North CI 95% = [0.168; 0.953], Southeast CI95% = [0.179; 0.506], South CI95% = [0.500; 1.652] and in the Midwest CI95% = [0.090; 0.983], among people with less education (<3 years of schooling). The trend was stabilized in this population after the Brazilian political crisis 2014.

After the global economic downturn of 2008, we also observed a statistically significant upward trend of the suicide rate in the Southeast CI95% = [0.015; 0.084], in the South CI95% = [0.006; 0.028] and in the Midwest region CI 95% = [0.006; 0.027] among people with  $\geq 8$  years of schooling CI95% = [0.006; 0.028]. After the economic and political crisis (2014–2017), the upward trend remained in the South CI95% = [0.037; 0.077] and Midwest region CI95% = [0.000; 0.018].

In Fig. 4, we can see the trend change in the Brazilian suicide rates considering age and region after the global economic downturn (2008–2013) and the Brazilian political crisis (2014–2017). During 2008 to 2013 in the Northeastern region, the change in rates resulted in a decreasing trend among the age group from 30 to 44 years old CI95% = [-0.424; -0.036], while the other regions remained at stable rates among all age groups compared to the period before 2008.

In 2014, when the Brazilian political crisis started, we found statistically significant upward trend rates in the South region CI95% = [0.0282; 1.021] for age range 30–44 years and in the Midwest, in the age group from 60 to 69 CI95% = [0.177; 2782]. However, suicide rates steadily declined in the Southeast regions with an age range from 30 to 44 years old CI95% = [-0.714; -0,200].

Data from all regions and variables results with their respective “p”

values, se and the trend in suicide mortality before and after the 2008 economic recession and political crisis in 2014 in Brazil are reported in Table 1 (online Supplement).

## Discussion

This study aimed at evaluating the association between economic recession periods and suicide rates in Brazil, a fiscally, socially, economically and demographically diverse country. We analyzed the correlation between suicide mortality rates and global economic and political crisis periods of 2008 and 2014. This relationship between economic recession times and rising suicide rates has been documented before in studies on the highest income countries, but less explored in developing countries (Barr et al., 2012; Houle & Light, 2017; Lopez Bernal et al., 2013; Stuckler, Basu, Suhrcke, Coutts, & McKee, 2009; Stuckler, Meissner, Fishback, Basu & McKee, 2012).

Overall, we found indications of statistically significant upward trends of suicide rates during the world economic crisis (2008–2013) and, later, during the economic and political crisis in Brazil (2014–2017) compared to earlier time periods. This trend was mostly influenced by the extremes of education levels, among the white and parda races. In the Northeast and South regions, we observed a significant increase in the trend rate for males after the Brazilian economic and political crisis (2014–2017).

The upwards trend in suicide rates in the individuals with low education during economic downturns and/or political crisis times is aligned with previous research (Desaulniers & Daigle, 2008; Injac Stevović, Jašović-Gašić, Vuković, Peković, & Terzić, 2011; Machado et al., 2015; Machado & Santos, 2015). This group presents a harder time relocating after job loss, which provides different levels of concerns

**Table 1**  
Trend in suicide mortality before and after the 2008 economic recession and political crisis in 2014, Brazil.

Categories	Trend change 2002/2007 ( $\beta_1$ )	se	p	Trend Change 2008/2013 ( $\beta_2$ )	se	p	Trend. incre/ decrea	Trend change 2014/2017 ( $\beta_3$ )	se	P	Trend incre/ decrea
<b>SEX</b>											
<b>Male</b>											
North	0.31	0.068	0.001	-0.147	0.119	0.239		-0.027	0.2	0.896	
Northeast	0.292	0.034	0.000*	-0.221	0.068	0.007*	↓	0.264	0.115	0.04*	↑
Southeast	0.085	0.034	0.029*	0.124	0.059	0.059		-0.335	0.1	0.006*	↓
South	0.02	0.061	0.749	-0.058	0.106	0.593		0.761	0.178	0.001*	↑
Midwest	-0.093	0.081	0.275	0.197	0.141	0.187		0.175	0.237	0.476	
<b>Female</b>											
North	-0.006	0.025	0.827	0.071	0.043	0.125		0.043	0.073	0.567	
Northeast	0.036	0.012	0.01*	-0.023	0.021	0.288		0.025	0.035	0.479	
Southeast	0.04	0.013	0.011*	0.022	0.023	0.367		-0.128	0.039	0.006*	↓
South	0.022	0.03	0.473	0.038	0.052	0.474		0.053	0.088	0.559	
Midwest	-0.093	0.039	0.033*	0.14	0.067	0.059		0.049	0.113	0.673	
<b>AGE GROUP</b>											
<b>15-29</b>											
North	0.203	0.078	0.023*	0.017	0.135	0.903		-0.25	0.228	0.295	
Northeast	0.127	0.036	0.004*	-0.119	0.063	0.084		0.098	0.106	0.373	
Southeast	0.032	0.043	0.474	0.071	0.074	0.36		-0.224	0.125	0.099	
South	-0.066	0.081	0.433	-0.055	0.141	0.705		0.379	0.238	0.137	
Midwest	-0.111	0.074	0.159	0.16	0.128	0.237		0.268	0.216	0.239	
<b>30-44</b>											
North	0.197	0.075	0.022*	-0.062	0.131	0.645		-0.173	0.221	0.448	
Northeast	0.161	0.051	0.009*	-0.23	0.089	0.024*	↓	0.207	0.15	0.194	
Southeast	0.137	0.04	0.005*	0.05	0.07	0.486		-0.457	0.118	0.002*	↓
South	-0.11	0.078	0.184	0.056	0.135	0.684		0.525	0.228	0.04*	↑
Midwest	-0.313	0.119	0.022	0.497	0.208	0.034*	↑	-0.245	0.35	0.498	
<b>45-59</b>											
North	0.042	0.124	0.738	-0.119	0.215	0.59		0.493	0.363	0.199	
Northeast	0.196	0.061	0.007*	-0.2	0.106	0.083		0.254	0.179	0.181	
Southeast	-0.093	0.062	0.158	0.219	0.108	0.066		-0.31	0.182	0.113	
South	-0.2	0.149	0.206	0.077	0.26	0.773		0.597	0.437	0.198	
Midwest	-0.297	0.089	0.006*	0.181	0.155	0.265		0.335	0.26	0.222	
<b>60-69</b>											
North	0.081	0.173	0.649	-0.107	0.301	0.729		0.818	0.507	0.133	
Northeast	0.233	0.115	0.065	-0.187	0.199	0.367		0.488	0.336	0.171	
Southeast	0.06	0.064	0.368	-0.05	0.111	0.662		0.206	0.187	0.292	
South	-0.234	0.196	0.254	0.138	0.34	0.693		0.656	0.573	0.275	
Midwest	0.033	0.204	0.874	-0.528	0.355	0.163		1.479	0.598	0.029*	↑
<b>RACE</b>											
<b>White</b>											
North	-0.16	0.05	0.008*	0.288	0.088	0.007*	↑	-0.02	0.148	0.894	
Northeast	0.024	0.026	0.389	0.01	0.046	0.832		0.044	0.077	0.582	
Southeast	0.084	0.02	0.001*	0.087	0.035	0.028*	↑	-0.174	0.059	0.012*	↓
South	0.112	0.035	0.008*	-0.085	0.061	0.189		0.534	0.103	0.000*	↑
Midwest	-0.211	0.067	0.008*	0.267	0.116	0.04*	↑	0.284	0.196	0.172	
<b>Black</b>											
North	-0.32	0.177	0.096	0.311	0.309	0.333		-0.104	0.52	0.844	
Northeast	0.021	0.03	0.503	-0.125	0.052	0.032*	↓	0.116	0.087	0.208	
Southeast	-0.008	0.046	0.87	0.004	0.081	0.961		-0.087	0.136	0.535	
South	-0.059	0.188	0.759	-0.157	0.326	0.638		0.55	0.549	0.336	
Midwest	-0.725	0.12	0.000*	0.814	0.209	0.002*	↑	-0.179	0.351	0.619	
<b>Yellow-skinned</b>											
North	-0.026	0.339	0.94	0.623	0.591	0.312		-1.232	0.994	0.239	
Northeast	-0.705	0.789	0.389	1.803	1.373	0.214		-3.558	2.312	0.15	
Southeast	-0.14	0.125	0.284	0.056	0.217	0.799		0.222	0.365	0.555	
South	-0.149	0.197	0.462	0.348	0.343	0.33		0.131	0.577	0.824	
Midwest	-0.402	0.411	0.347	0.895	0.716	0.235		-1.85	1.205	0.151	
<b>Parda</b>											
North	-0.004	0.072	0.955	0.178	0.126	0.183		-0.184	0.212	0.402	
Northeast	0.319	0.035	0.000*	-0.262	0.062	0.001*	↓	0.396	0.104	0.002*	↑
Southeast	0.066	0.015	0.001	0.116	0.027	0.001*	↑	-0.327	0.045	0.000*	↓
South	-0.064	0.06	0.304	0.101	0.103	0.348		0.073	0.175	0.686	
Midwest	0.2	0.055	0.003	-0.062	0.095	0.524		-0.052	0.16	0.752	
<b>Indigenous</b>											
North	0.812	2.817	0.778	-6.906	4.902	0.184		8.839	8.255	0.305	
Northeast	-0.303	0.189	0.134	0.413	0.328	0.232		0.101	0.553	0.858	
Southeast	0.019	0.195	0.923	-0.052	0.339	0.88		0.465	0.57	0.43	
South	-0.325	0.561	0.573	1.862	0.976	0.081		-3.726	1.644	0.043*	↓
Midwest	-5.967	3.542	0.118	9.133	6.163	0.164		4.891	10.379	0.646	
<b>EDUCATION</b>											
<b>&lt;=3 years</b>											
North	-0.243	0.103	0.037	0.561	0.18	0.009*	↑	-0.309	0.303	0.328	

(continued on next page)

Table 1 (continued)

Categories	Trend change 2002/2007 ( $\beta_1$ )	se	p	Trend Change 2008/2013 ( $\beta_2$ )	se	p	Trend. incre/ decrea	Trend change 2014/2017 ( $\beta_3$ )	se	P	Trend incre/ decrea
Northeast	0.272	0.057	0,000*	-0.108.	0.1	0.298		0.101	0.168	0.558	
Southeast	-0.028	0.043	0.524	0.343	0.075	0.001*	↑	-0.541	0.126	0,001*	↓
South	-0.525	0.15	0.004	1.701	0.262	0.001*	↑	-0.598	0.441	0.2	
Midwest	-0.134	0.118	0.278	0.537	0.205	0.022*	↑	-0.402	0.345	0.267	
<b>4-7years</b>											
North	0.162	0.098	0.124	0.068	0.17	0.696		-0.361	0.286	0.232	
Northeast	0.327	0.036	0,000*	-0.232	0.063	0.003*	↓	0.427	0.106	0.002*	↑
Southeast	0.152	0.036	0.001*	0.22	0.063	0.005*	↑	-0.284	0.106	0.02*	↓
South	0.584	0.077	0,000*	-0.44	0.134	0.006*	↓	0.375	0.225	0.121	
Midwest	0.245	0.124	0.072	0.072	0.217	0.744		0.103	0.365	0.782	
<b>≥ 8 years</b>											
North	0.034	0.013	0.026*	0.041	0.023	0.102		0.02	0.039	0.617	
Northeast	0.073	0.007	0,000*	0.01	0.013	0.463		0.133	0.021	0,000*	↑
Southeast	0.089	0.009	0,000*	0.05	0.016	0.008*	↑	0.014	0.027	0.597	
South	0.02	0.003	0,000*	0.017	0.005	0.006*	↑	0.057	0.009	0,000*	↑
Midwest	0.003	0.001	0.056	0.008	0.002	0.003*	↑	0.009	0.004	0.024*	↑

and stress (Desaulniers & Daigle, 2008; Machado & Santos, 2015). Although, an economic downturn itself cannot be considered as responsible for the increase in suicide rates, socioeconomic tensions during these moments, such as job loss, financial and relationship difficulties, job cuts and government austerity measures can contribute to rising suicide rates (Barr et al., 2012; Cunha & Santos, 2014; Hawton & Haw, 2013). The upwards trend in suicide rates in the individuals with high educational level during economic downturns could be associated with threatened by cuts in the higher-paying jobs, the unavailability of work, or work potentially being more stressful which can lead to them being under greater mental stress (Lin, 2006). An individual's schooling can also influence their self-esteem and lead to suicidal tendencies (Machado & Santos, 2015; Pochmann, 2015). We can understand that both groups, with low and high educational levels, become vulnerable in the face of a financial crisis. Unemployment is not homogeneous and affects different groups in relation to educational level. However, education level and unemployment influence income inequality, an important determinant of suicide in Brazil (Machado et al., 2015).

As in previous study, a increase suicide mortality rate was found in the white and parda population (Machado & Santos, 2015). Historically, the dominant social groups in Brazil are formed by white people of wealthy economic and social condition, which guarantees them social ascension in higher status functions (Cunha & Santos, 2014; Ferreira & Queiroz, 2018). An economic and/or political crisis makes social groups face the threat and fear of failure, losing achievements and privileges. Studies suggest that losing position and status in privileged groups generates a feeling of anxiety, failure and shame in the face of financial losses, which affects their mental health (Houle & Light, 2017; Norris, 2016). Usually, parda population does not belong to dominant social groups in Brazil (Brazilian Institute of Geography and Statistics, 2018). The parda population face a shortage of jobs and difficult access to education (Brazilian Institute of Geography and Statistics, 2018). Machado and Santos (2015) have already pointed to an increase in the suicide mortality rates from 3.3/100.000 inhabitants in 2000 to 5.9/100.000 inhabitants in 2012 among parda throughout Brazil. It is likely that this growing trend is related to the socioeconomic characterization of this population: according to IBGE (Brazilian Institute of Geography and Statistics, 2017), the illiteracy rate is greater than double and the monthly income is lower than white people's (Brazilian Institute of Geography and Statistics, 2017; Gonçalves, Gonçalves, & Oliveira Júnior, 2011). These characteristics represent risk factors for suicide in economic downturns times, due to greater exposure factors, such as stress caused by financial problems, instability, alcoholism and mental health problems (Machado et al., 2015; Stack, 2000).

The males showed an increasing trend in suicide rates after economic and political crisis times. These findings confirm an increase in suicide mortality rates in Brazil among men throughout the study period (Lovisi,

Santos, Legay, Abelha, & Valencia, 2009; Machado & Santos, 2015). Brazil follows the worldwide pattern where males are more likely to become a victim of suicide (Alicandro et al., 2019; Machado et al., 2019). Researchers have identified that one of the main factors that justify higher suicide rates among men is the greater exposure that they have to feelings of bankruptcy in face of financial failure and competitiveness in the labor Market, alcohol use, access and use of more lethal (Machado & Santos, 2015; Santos, 2010; Santos et al., 2009; Nock et al., 2008). While women care more about their own health, especially mental and emotional health, and that they seek professional help with less resistance than men (Lovisi et al., 2009; Santos, 2021; Stefanello, Cais, Mauro, Freitas, & Botega, 2008). These female characteristics corroborate the data found in our research, since we did not detect an increase in suicide rates among women in any Brazilian region at any of crisis periods analyzed. In contrast, there was a decreasing trend in the southeast after 2014.

This study was limited by the use of secondary data, which may contain gaps from the information system register, as well as under-reporting that was showed with education level. In addition, some data related to the study variables that would be important for a better analysis of the suicide vs economic downturns relationship, such as occupation, income and education could not be provide by the databases used in the research. However, the use of advanced statistical methods (interrupted time series) to verify the effect of economic downturns and a political crisis on the tendency of suicide mortality rates in the country aims to minimize such limitations.

We understand that the peculiarities of each region need to be considered in isolation, for a better assessment of the suicide phenomenon in the different Brazilian regions. However, understanding the correlation between suicide and economic downturns and political crisis times, analyzed in different variables (education, race, gender and age group), represents an important guide for proposing public health and economic promotion policies that aim to minimize damage to mental health of the population during these situations. Further studies are needed to explore the reasons for interregional and international differences, as well as studies evaluating the relationship of suicide with unemployment rates and other possible economic predictors.

#### Authors' statement

Eliane Maria Spiecker: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Writing – original draft; Writing. Patrícia Costa Mincoff Barbanti: Conceptualization; Data curation; Investigation; Writing – original draft. Paulo Acácio Egger: Conceptualization; Investigation. Maria Dalva de Barros Carvalho: Conceptualization; Writing – review & editing. Sandra Marisa Pelloso: Conceptualization; Writing – review & editing. Marta Rovera de

Souza: Writing – review & editing. Luciano de Andrade: Data curation; Writing – review & editing. Catherine A. Staton: Writing – review & editing. Marcia Lorena Alves: Formal analysis; Methodology. Eniuce Menezes de Souza: Formal analysis; Methodology; Writing – review & editing. Raíssa Bocchi Pedroso: Conceptualization; Formal analysis; Investigation; Project administration; Writing – original draft; Writing – review & editing. João Ricardo Nickenig Vissoci: Conceptualization; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Supervision; Writing – review & editing.

## Acknowledgements

This work was carried out with the support of the Coordination for the Improvement of Higher Education Personnel Brazil (CAPES) - Financing Code 001.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2021.100754>.

## References

- Alicandro, G., Malvezzi, M., Gallus, S., La Vecchia, C., Negri, E., & Bertuccio, P. (2019). Worldwide trends in suicide mortality from 1990 to 2015 with a focus on the global recession time frame. *International Journal of Public Health*, 64(5), 785–795. <https://doi.org/10.1007/s00038-019-01219-y>. Jun 1.
- Alves, F. J., Machado, D. B., & Barreto, M. L. (2019). Effect of the Brazilian cash transfer programme on suicide rates: A longitudinal analysis of the Brazilian municipalities. *Social Psychiatry and Psychiatric Epidemiology*, 54(5), 599–606. <https://doi.org/10.1007/s00127-018-1627-6>. May 1.
- Barr, B., Taylor-Robinson, D., Scott-Samuel, A., McKee, M., & Stuckler, D. (2012). Suicides associated with the 2008–10 economic recession in England: Time trend analysis. *Aug 14 BMJ*, 345, e5142. <https://doi.org/10.1136/bmj.e5142>.
- Brazilian Institute of Geography and Statistics. (2017). Brazil. Cities and states. Date <http://www.ibge.gov.br/cidades-e-estados>. (Accessed 10 June 2018).
- Brazilian Institute of Geography and Statistics. (2018). *Brazil. Historical series*. Date <https://www.ibge.gov.br/en/home-eng.html>. (Accessed 10 May 2019).
- Carcanholo, M., Pinto, E., Filgueiras, L., & Gonçalves, R. (2008). *International financial crisis-nature and impact*. Public debt illegitimacy: who owes whom.
- Chang, S. S., Gunnell, D., Sterne, J. A., Lu, T. H., & Cheng, A. T. (2009 Apr 1). Was the economic crisis 1997–1998 responsible for rising suicide rates in East/Southeast Asia? A time-trend analysis for Japan, Hong Kong, South Korea, Taiwan, Singapore and Thailand. *Social Science & Medicine*, 68(7), 1322–1331. <https://doi.org/10.1016/j.socscimed.2009.01.010>
- Chang, S. S., Stuckler, D., Yip, P., & Gunnell, D. (2013). Impact of 2008 global economic crisis on suicide: Time trend study in 54 countries. *Sep 17 BMJ*, Article 347:f5239. <https://doi.org/10.1136/bmj.f5239>. Available:
- Chatfield, C. (2003). *The analysis of times series: An introduction*. CRC press. Jul 29.
- Chesney, E., Goodwin, G. M., & Fazel, S. (2014). Risks of all-cause and suicide mortality in mental disorders: A meta-review. *Jun World Psychiatry*, 13(2), 153–160. <https://doi.org/10.1002/wps.20128>.
- Classen, T. J., & Dunn, R. A. (2012). The effect of job loss and unemployment duration on suicide risk in the United States: A new look using mass-layoffs and unemployment duration. *Health Economics*, 21(3), 338–350. <https://doi.org/10.1002/hec.1719>. Mar.
- Cochrane, D., & Orcutt, G. H. (1949). Application of least squares regression to relationships containing auto-correlated error terms. *Journal of the American Statistical Association*, 44(245), 32–61. Mar 1.
- Coope, C., Gunnell, D., Hollingworth, W., Hawton, K., Kapur, N., Fearn, V., et al. (2014). Suicide and the 2008 economic recession: Who is most at risk? Trends in suicide rates in England and Wales 2001–2011. *Social Science & Medicine*, 117, 76–85. *Sep 1*.
- Cryer, J. D., & Chan, K. S. (2008). *Time series analysis: With applications in R*. Springer-Verlag New York press.
- Cunha, R. R., & Santos, A. D. (2014 Dec). Aníela Meyer Ginsberg and the studies of race/ethnicity and interculture in Brazil. *Psicologia USP*, 25(3), 317–329. <https://doi.org/10.1590/0103-656420130013>. Available:
- Department of the Unified Health System. (2018). Health information system, Brazil. Health, demographic and socioeconomic information. Date <http://www2.datasus.gov.br/DATASUS/index.php?area=0206>. (Accessed 13 July 2018).
- Desaulniers, J., & Daigle, M. S. (2008). Inter-regional variations in men's attitudes, suicide rates and sociodemographics in Quebec (Canada). *Social Psychiatry and Psychiatric Epidemiology*, 43(6), 445–453. <https://doi.org/10.1007/s00127-008-0340-2>. Jun 1.
- Durbin, J., & Watson, G. S. (1951). Testing for serial correlation in least squares regression. *II. Biometrika*, 38, 159–177.
- Ferreira, G. L., & Queiroz, M. V. L. (2018). The trajectory of Critical Race Theory: history, concepts and reflections to think about Brazil. *Contemp. Leg. Theor.*, 3(1), 201–229. <https://revistas.ufjr.br/index.php/rjur/article/download/18291/12545>.
- Gimenez, D. M. (2017). Available :. *Social policy and regional imbalances in Brazil in times of crisis. Text for discussion* (Vol. 301, pp. 1–25). May <http://www.eco.unicamp.br/doi/ocprod/downarq.php?id=3530&tp=a>. Access: 2019 Jan.
- Gonçalves, L. R., Gonçalves, E., & Oliveira Júnior, L. B. (2011). Spatial and socioeconomic determinants of suicide in Brazil: A regional approach. *Aug New Economy*, 21(2), 281–316. <https://doi.org/10.1590/S0103-63512011000200005>. Available:
- Hassett, A. L., Aquino, J. K., & Ilgen, M. A. (2014). The risk of suicide mortality in chronic pain patients. *Aug 1 Current Pain and Headache Reports*, 18(8), 436. <https://doi.org/10.1007/s11916-014-0436-1>.
- Hawton, K., & Haw, C. (2013). Economic recession and suicide: The association is clear but government response may limit its extent. *BMJ British Medical Journal*, 347 (7925), 9. <https://doi.org/10.1136/bmj.f5612>. *Sep 21*.
- Hawton, K., & Heeringa, K.v. (2009). *Suicide. Lancet*, 393, 1372–1381. [https://doi.org/10.1016/S0140-6736\(09\)60372-X](https://doi.org/10.1016/S0140-6736(09)60372-X)
- Houle, J. N., & Light, M. T. (2017). The harder they fall? Sex and race/ethnic specific suicide rates in the US foreclosure crisis. *Social Science & Medicine*, 180, 114–124. <https://doi.org/10.1016/j.socscimed.2017.03.033>. May 1.
- Injac Stevović, L., Jašović-Gašić, M., Vuković, O., Peković, M., & Terzić, N. (2011). Gender differences in relation to suicides committed in the capital of Montenegro (Podgorica) in the period 2000–2006. *Psychiatry Danubina*, 23(1), 45–52. *Mar 31*.
- Karanikolos, M., Mladovsky, P., Cylus, J., Thomson, S., Basu, S., Stuckler, D., et al. (2013). Financial crisis, austerity, and health in Europe. *The Lancet*, 381(9874), 1323–1331. [https://doi.org/10.1016/S0140-6736\(13\)60102-6](https://doi.org/10.1016/S0140-6736(13)60102-6). *Apr 13*.
- Kerr, W. C., Subbaraman, M., & Ye, Y. U. (2011). Per capita alcohol consumption and suicide mortality in a panel of US states from 1950 to 2002. *Sep Drug and Alcohol Review*, 30(5), 473–480. <https://doi.org/10.1111/j.1465-3362.2011.00306.x>.
- Kim, S. H. (2016). Suicidal ideation and suicide attempts in older adults: Influences of chronic illness, functional limitations, and pain. *Jan 1 Geriatric Nursing*, 37(1), 9–12. <https://doi.org/10.1016/j.gerinurse.2015.07.006>. Available:
- Lin, S. J. (2006). Unemployment and suicide: Panel data analyses. *The Social Science Journal*, 43(4), 727–732. <https://doi.org/10.1016/j.soscij.2006.08.013> Date: 2006. Dec 1 . (Accessed 15 February 2020).
- Lopez Bernal, J. A., Gasparrini, A., Artundo, C. M., & McKee, M. (2013). The effect of the late 2000s financial crisis on suicides in Spain: An interrupted time-series analysis. *Oct 1 The European Journal of Public Health*, 23(5), 732–736. <https://doi.org/10.1093/eurpub/ckt083>.
- Lovisi, G. M., Santos, S. A., Legay, L., Abelha, L., & Valencia, E. (2009). Epidemiological analysis of suicide in Brazil between 1980 and 2006. *Brazilian Journal of Psychiatry*, 31, S86–S93. <https://doi.org/10.1590/S1516-44462009000600007>. *Oct*.
- Machado, D. B., Pescarini, J. M., Araújo, L. F., & Barreto, M. L. (2019). Austerity policies in Brazil may affect violence related outcomes. *Nov 25 Ciência & Saúde Coletiva*, 24, 4385–4394. <https://doi.org/10.1590/1413-812320182412.07422019>.
- Machado, D. B., Rasella, D., & dos Santos, D. N. (2015). Impact of income inequality and other social determinants on suicide rate in Brazil. *PLoS One*, 10(4). <https://doi.org/10.1371/journal.pone.0124934>
- Machado, D. B., & Santos, D. N. (2015). Suicídio no Brasil, de 2000 a 2012. *Jornal Brasileiro de Psiquiatria*, 64(1), 45–54. <https://doi.org/10.1590/0047-2085000000056>. *Mar*.
- Ministry of Health. (2017). Brazil. Strategic actions agenda for surveillance and prevention of suicide and health promotion in Brazil: 2017 to 2020. Date [http://bvsm.sau.gov.br/bvs/publicacoes/acoes\\_estrategicas\\_vigilancia\\_prevencao\\_suicidio.pdf](http://bvsm.sau.gov.br/bvs/publicacoes/acoes_estrategicas_vigilancia_prevencao_suicidio.pdf). (Accessed 17 May 2018).
- Moretting, P. A., & Tolo, C. M. (2004). *Time series analysis*.
- Mortoza, L. P., & Piqueira, J. R. (2017). Measuring complexity in Brazilian economic crises. *PLoS One*, 12(3). <https://doi.org/10.1371/journal.pone.0173280>
- Nock, M. K., Borges, G., Bromet, E. J., Cha, C. B., Kessler, R. C., & Lee, S. (2008). Suicide and suicidal behavior. *Epidemiologic Reviews*, 30(1), 133–154. <https://doi.org/10.1093/epirev/mxn002>. *Nov 1*.
- Norris, D. R. (2016). *Job loss, identity, and mental health*. Rutgers University Press. *Jun 13*.
- Paula, L. F., & Pires, M. (2017). Crisis and perspectives for the Brazilian economy. *Advanced Studies*, 31(89), 125–144. <https://doi.org/10.1590/s0103-40142017.31890013>. *Apr*.
- Pochmann, M. (2015). Economic adjustment and recent unemployment in metropolitan Brazil. *Advanced Studies*, 29(85), 7–19. <https://doi.org/10.1590/S0103-40142015008500002>. *Dec*.
- Reichenheim, M. E., De Souza, E. R., Moraes, C. L., de Mello Jorge, M. H., Da Silva, C. M., & de Souza Minayo, M. C. (2011). Violence and injuries in Brazil: The effect, progress made, and challenges ahead. *The Lancet*, 377(9781), 1962–1975. [https://doi.org/10.1016/S0140-6736\(11\)60053-6](https://doi.org/10.1016/S0140-6736(11)60053-6). *Jun 4*.
- Rukundo, G. Z., Mishara, B. L., & Kinyanda, E. (2016). Burden of suicidal ideation and attempt among persons living with HIV and AIDS in semiurban Uganda. <https://doi.org/10.1155/2016/3015468>. *AIDS research and treatment*.
- Santos, J. D. (2010). *Suicide in mato grosso do sul. Brazil: sociodemographic factors* (Doctoral dissertation) (p. 2010). Label: Santos <https://www.arca.fiocruz.br/handle/icict/24211>.
- Santos, S. A., Lovisi, G., Legay, L., & Abelha, L. (2009). Prevalence of mental disorders in suicide attempts at an emergency hospital in Rio de Janeiro, Brazil. *Public Health Notebooks*, 25, 2064–2074. <https://doi.org/10.1590/S0102-311X2009000900020>
- Santos, I. S., & Vieira, F. S. (2018). The right to healthcare and fiscal austerity: The Brazilian case from an international perspective. *Ciência & Saúde Coletiva*, 23, 2303–2314. <https://doi.org/10.1590/1413-81232018237.09192018>
- Stack, S. (2000). Suicide: A 15-year review of the sociological literature part I: Cultural and economic factors. *Suicide and Life-Threatening Behavior*, 30(2), 145–162. <https://doi.org/10.1111/j.1943-278X.2000.tb01073.x>. *Jun*.



- Stack, S., & Wasserman, I. (2007 Feb). Economic strain and suicide risk: A qualitative analysis. *Suicide and Life-Threatening Behavior*, 37(1), 103–112.
- Stefanello, S., Cais, C. F., Mauro, M. L., Freitas, G. V., & Botega, N. J. (2008). Gender differences in suicide attempts: Preliminary results of the multisite intervention study on suicidal behavior (SUPRE-MISS) from campinas, Brazil. *Brazilian Journal of Psychiatry*, 30(2), 139–143. <https://doi.org/10.1590/S1516-44462006005000063>. Jun.
- Stickley, A., Koyanagi, A., Ueda, M., Inoue, Y., Waldman, K., & Oh, H. (2020). Physical multimorbidity and suicidal behavior in the general population in the United States. Jan 1 *Journal of Affective Disorders*, 260, 604–609. <https://doi.org/10.1016/j.jad.2019.09.042>. Available:.
- Stuckler, D., Basu, S., Suhrcke, M., Coutts, A., & McKee, M. (2009). The public health effect of economic crises and alternative policy responses in europe: An empirical analysis. *The Lancet*, 374(9686), 315–323. [https://doi.org/10.1016/S0140-6736\(09\)61124-7](https://doi.org/10.1016/S0140-6736(09)61124-7). Jul 25.
- Stuckler, D., Meissner, C., Fishback, P., Basu, S., & McKee, M. (2012). Banking crises and mortality during the great depression: Evidence from US urban populations, 1929–1937. *Journal of Epidemiology & Community Health*, 66(5), 410–419. <https://doi.org/10.1136/jech.2010.121376>. May 1.
- World Health Organization. (2014). *Preventing suicide: A global imperative*. World Health, Organization <https://www.who.int/publications-detail/preventing-suicide-a-global-imperative>.