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Mortality by suicide: a comparative study of Amapá with the Northern region of Brazil (2008-2017)

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Abstract

This study aimed to compare suicide mortality rates in the Northern region of Brazil and in Amapá, in addition to plotting temporal trends in mortality for the seven states and the region, during the period from 2008 to 2017. This is a retrospective time-series study (2008-2017). Suicide data recorded in the states of the Northern region were extracted from the Brazilian Public Security Yearbook. The source of population data, used for mortality calculations (×100,000), was the IBGE. To extract the trend of the series, simple temporal regressions were used. The SPSS 20.0 software was used. During the period examined 4,438 suicides were registered in the Northern region, of which 172 (3.88%) were in Amapá. There was no significant difference between the means of suicide mortality in Amapá ($\bar{x}$=2.65±1.12) and that in the Northern region ($\bar{x}$=2.66±0.72). However, it is necessary to consider the influence of underreporting in the time-series analysis of Amapá. The temporal regressions showed a significant upward trend in the suicide mortality rate in the Northern region (R^2=0.566; p=0.012), in the state of Pará (R^2=0.606; p<0.01), and in the state of Amazonas (R^2=0.729; p<0.01). This growth may be, in part, related to socioeconomic factors, the increased vulnerability of population groups at risk and the improvement of health information services/systems that have taken place in recent years in Brazil. Thus, the results showed an increase in mortality from suicide in the Northern region and in two of its two most populous states. This indicates that prevention policies need to be strengthened, with special attention to the region's most vulnerable populations, such as indigenous peoples.

Key words: Brazil. Suicide. Regression Analysis.

INTRODUCTION

Suicide can be defined as a death caused, immediately or not, by an action of the victim[1]. According to the World Health Organization, between the years 2000 (883,000 registered cases) and 2012 (804,000 registered cases) there was a 9.0% reduction in the absolute number of suicides in the world, although this pattern of reduction was not observed in all regions of the planet[2]. In Brazil, for example, mortality from suicide and the absolute quantity of deaths increased from 1996 to 2015, a period in which 171,051 deaths from suicide were reported in the country[3]. According to the Epidemiological Bulletin[4], between 2011 and 2015 alone, 55,649 deaths from suicide were reported in Brazil, with an overall rate of 5.5 deaths/100,000 inhabitants, 8.7 deaths/100,000 for males (four times higher than for females)

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and 15.2 deaths/100,000 for indigenous people (about three times greater than in the white race/color). Regarding the means of aggression, the most used was hanging, followed by exogenous intoxication and the use of a firearm[4].

The Northern region of Brazil, which concentrates most of the country's indigenous people and had, in 2017, a total population of approximately 18.0 million inhabitants[5,6], is located in the Legal Brazilian Amazon and is geographic isolation with a history of uneven social development in health and in the economy, when compared to other regions of the country. In this region is Amapá, a state also marked by low income and poor health indicators, which has a great socioeconomic contrast with the rest of the country, especially when analyzing the cities in the interior of the state. In 2010, half of the municipalities in the state had a per capita income of less than US$200.00[7].

In this context, it is highlighted that socioeconomic factors, combined with other individual and collective aspects, may be associated with a higher occurrence of suicide[4]. However, the Northern region has the lowest absolute quantity of reported suicide cases among Brazilian regions, although it has presented the highest rate of positive variation in mortality between the years 1996 and 2015[3]. It is important to emphasize the possible interference of underreporting as a factor that underestimates the absolute number of cases in the country[3,8].

Some of the main risk factors for suicide are linked to mental health, with depression, bipolar disorder, chemical dependency, and schizophrenia being related to greater chances of attempting or performing a suicide[2]. In addition, the ease of access to means that make it possible to self-inflict fatal injuries, such as firearms and pesticides, can influence the mortality rates in different locations[4,9]. Other relevant aspects related to suicide, especially among vulnerable populations such as indigenous peoples, may be exposure to alcoholic beverages, psychoactive substances, and urban poverty with a loss of sociocultural identity[4,10]. However, although some risk factors are well demonstrated in the literature, it is highlighted that suicide must be considered a complex and multifactorial event, involving psycho-emotional, spiritual, sociocultural, and economic aspects[4]. And that simple generalizations about its possible causes are, for the most part, insufficient to explain this phenomenon[4].

Thus, the importance of conducting epidemiological studies that analyze suicide mortality in regions of vulnerability and the lack of research on the subject is highlighted, as is the case in the Northern region and, in particular, in the state of Amapá. Therefore, considering the relevance of the subject in the context of public health, this study aimed, with reference to the period from 2008 to 2017, to compare the average suicide mortality rates in the Northern region and in Amapá, in addition to tracing temporal trends in mortality for the seven states and for the overall region.

METHODS

Data source and methodological justification

This is an ecological, time-series analytical study that analyzed cases of suicide that occurred in the states of Northern Brazil between the years 2008 and 2017. Ecological studies analyze the occurrence of a health problem, a disease or a condition in a certain aggregate group of people, such as the population of a state, a country, or a region[11]. The time-series analytical method uses statistical tests and tools to identify trends and behaviors

of a time-series, as well as comparing measures of central tendency from different time-series. Therefore, a time-series can be defined as the temporal organization of quantitative data, in this study an annual interval was used[11,12]. This design has already been applied in studies on mortality/incidence from external causes, such as suicide[3,13,14], homicides[13], and accidents at work[15] and during transportation[13].

This study was based on secondary data, extracted from the Brazilian Public Security Yearbooks (BPSYs), which are produced by the Brazilian Public Security Forum (BPSF), originating from the state security secretariats[16]. In this study, the BPSYs published between the years 2018-2010 were used[17]. It is noteworthy that each BPSY provides data referring to the two previous years in relation to the year of the yearbook title. Thus, the period studied was from 2008 to 2017.

All data, available in the ABSPs, referring to the states of the northern region of Brazil (Acre, Amapá, Amazonas, Pará, Rondônia, Roraima, Tocantins) were included, except for the year 2011 in the state of Amapá (referred to as "non-existent phenomenon" by ABSP 2012 and ABSP 2011) and the year 2017 in the state of Roraima (referred to as "information not available" by ABSP 2018). These years (2011 and 2017), exclusively in the aforementioned states (Amapá and Roraima), were excluded from the comparison analysis (Amapá × North region except Amapá) and from the mortality trend, as these are extremely unusual observations, which indicates probable underreporting or information errors.

The population data, used to calculate suicide mortality rates in the Northern region and its states, were taken from the resident population estimate 'Major Regions and Federation Units' (2001-2018)[6], produced by the Brazilian Institute of Geography and Statistics (IBGE).

Therefore, to calculate the quantity of suicides in the Northern region, and the annual mortality rates in the region, a simple summation, year-by-year, was performed of the quantity of suicides that occurred in each of the seven states that comprise the region. Furthermore, to eliminate any degree of dependence between mortality in the state of Amapá and in the Northern region, the number of deaths and the population related to Amapá was subtracted from the Northern region for the analysis of comparison of the average mortality rate. Thus, the variable named "Northern region except Amapá" (NREAp) corresponds to the sum, year-by-year, of deaths by suicide and populations in the states of the North region except the state of Amapá.

Statistical analysis

The statistical software used were the Statistical Package for Social Sciences 20.0 and Origin Pro 8.5. Trend analyses were preceded by qualitative assessment of scatter plots (Quantil-Quantil Plot) of annual mortalities, by state, and by the non-parametric Kolmogorov-Smirnov (KS) test to verify the hypothesis of normal distribution of data. In this test, the hypothesis of normal distribution was accepted when p-value > 0.05.

In the analysis of the time-series trend of suicide mortality rates, a simple temporal regression was used. To define the polynomial models, the adjustments to the data of each state and the Northern region were evaluated, through the analysis of the coefficient of determination (R^2) and the analysis of residues (verification of homoscedasticity and distribution of non-standardized residues), preferably choosing a simpler polynomial model, when the fit was equal. Thus, among all polynomial models tested (linear, second order, third order, and exponential) in six of the seven regressions performed, the linear polynomial was chosen, and in only one case was the exponential model used. In these equations, regardless of the type of polynomial, 'Y^' represents the mortality per

100,000 inhabitants predicted by the model for a given year (represented by 'X'). Regression was considered significant when the I-value of the F test for analysis of variance was ≤ 0.05.

To compare the mean suicide mortality rates in the state of Amapá (n=9) × NREAp (n=10), the parametric Student's t test for independent samples was used, preceded by the KS test and the Levene's test (based on the average). In the t test, the difference between means was considered significant when p-value ≤ 0.05.

RESULTS

During the years 2008 to 2017, 4,438 deaths by suicide were recorded in the states of the Northern region. Most of the deaths by suicide were reported in the state of Pará 1,685 (37.97%), the numbers reported in the other states of the region were: 378 (8.52%) cases in Acre, 689 (15.53%) in the Amazonas, 819 (18.45%) in Rondônia, and 516 (11.63%) in Tocantins. In Roraima and Amapá, respectively, 179 (4.03%) and 172 (3.88%) deaths by suicide were reported. Although these are the two lowest quantitative figures identified in this study, it is important to highlight that these two states contained only nine years in their time-series.

The average suicide mortality rate in Amapá was 2.65±1.12 cases per 100,000 inhabitants, very close to the average rate identified in the NREAp, which was 2.66±0.72 cases per 100,000 inhabitants. Student's t test for independent samples, used to compare the values of the two time-series, did not show a significant difference between the means (p-value=0.987). However, the medians were 2.39 deaths by suicide/100,000 inhabitants in the state of Amapá and 2.91 in the NREAp (Table 1). It is noteworthy that the year 2011 was excluded from the analysis of the Amapá time-series due to probable underreporting or information error.

Furthermore, the temporal regressions (2008-2017), used to identify patterns of growth or decay in the analyzed time-series, showed a significant increasing trend in the suicide mortality rate in the Northern region (R^2=0.566; p-value=0.0120) and an increasing trend, without statistical significance, in the state of Amapá (R^2=0.073; p-value=0.4821). The R^2 of 0.566, from the regression of the Northern region, permits the inference that the polynomial model was able to explain 56.6% of the data variance. The R^2 of the temporal regression of Amapá was only 0.073. That is, with the potential to explain only 7.3% of the data variance and, therefore, without statistical significance.

In the time-series for the Northern region, the year with the highest suicide mortality rate was 2015, with 3.46 deaths from suicide/100,000 inhabitants, while the year with the lowest mortality was the year 2011 (1.44 deaths/100,000 inhabitants). In the time-series for the state of Amapá, the highest incidence of mortality was identified in 2017, with 4.64 deaths/100,000 inhabitants, while the lowest was in 2010, with 1.20 deaths/100,000 inhabitants. The other results of the temporal regressions carried out and the descriptive statistics, referring to the Northern region and the seven states that compose it, are presented in Table 2 and in Figure 1, respectively.

As shown in Table 2 and Figure 1, in addition to the Northern region only the temporal regressions performed for the state of Pará (R^2=0.606; p-value=0.0079) and for the state of Amazonas (R^2=0.729; p-value=0.0017) were significant, both with a temporal trend of increasing suicide mortality rates. As for the

descriptive statistics of mortality from suicide in these two states, it was observed that the average mortality rate was $\bar{x}$=2.11±1.01, with a maximum mortality of 3.30 in 2016, a minimum of 0.64 in 2011, and median of 2.33. In the state of Amazonas, the mean rate in the study period was $\bar{x}$=1.82±0.79, the lowest identified in this study, with a maximum mortality of 3.07 in 2015, a minimum of 0.80 in 2010, and a median of 1.80 deaths/100,000 inhabitants.

The states of Acre ($\bar{x}$=4.92±1.96) and Rondônia ($\bar{x}$=4.94±0.79) had the highest average suicide mortality rate in the period from 2008 to 2017. The trends in the time-series analysis of these two states showed an increase in mortality from suicide, but without statistical significance and with a low fit of the models to the data.

Table 1 - Results of the statistical analysis comparing the average suicide mortality rates (×100,000 inhabitants) in the state of Amapá and in the Northern region of Brazil, between 2008 and 2017.

	State of Amapá (n=9)				NREAp (n=10)				p-value Levene test	p-valor teste t de Student
Mortality rate	Mean 2.65	SD ±1.12	Median 2.39	Variance 1.25	Mean 2.66	SD ±0.72	Median 2,91	Variance 0.51	0.334[1]	0.987[2]

[1] The hypothesis of homogeneity of variances was accepted; 2 There was no significant difference between means; NREAp: Northern region except Amapá state; SD: Standard Deviation.

Table 2 - Results of temporal regressions performed for suicide mortality rates (×100,000 inhabitants) in the North region and its seven states, 2008 to 2017.

State / region	p-value KS test	Polynomial Regression Model	R^2	p-value F test	Tendency
Northern Region	0.551	$Y^{\wedge}= 0.178 \times X - 355.27$	0.566	0.0120*	Growing
Acre	0.933	$Y^{\wedge}= 0.201 \times X - 400.89$	0.097	0.3801	Growing
Amapá[1]	0.959	$Y^{\wedge}= 0.096 \times X - 189.73$	0.073	0.4821	Growing
Amazonas	0.888	$Y^{\wedge}= 2.144 \times 10^{-115} \times e^{(-0.131 \times X)}$	0.729	0.0017*	Growing
Pará	0.865	$Y^{\wedge}= 0.260 \times X - 522.45$	0.606	0.0079*	Growing
Rondônia	0.956	$Y^{\wedge}= 0.033 \times X - 61.39$	0.016	0.7268	Growing
Roraima[1]	0.896	$Y^{\wedge}= 0.092 \times X - 180.08$	0.071	0.4891	Growing
Tocantins	0.877	$Y^{\wedge}= -0.130 \times X + 265.25$	0.251	0.1402	Descending

[1] Number of years analyzed = 9; *Temporal regression was significant; KS: Kolmogorov-Smirnov; R^2: Coefficient of determination.

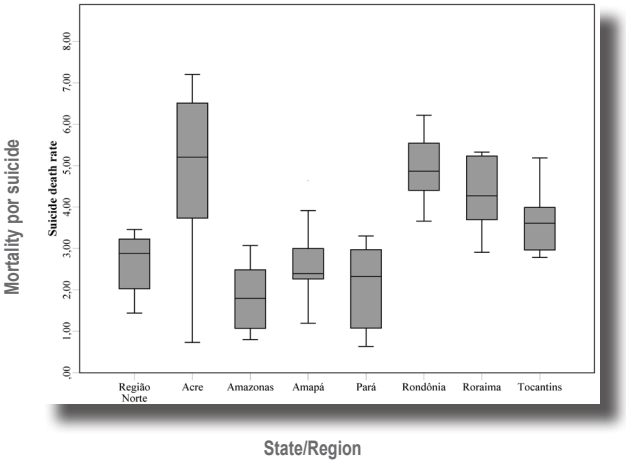

Figure 1 - Box diagram of suicide mortality rates (×100,000 inhabitants) in the Northern region and its seven states, 2008 to 2017.

DISCUSSION

Suicide is a global public health problem, although the number of suicides has decreased between 2000 and 2012, approximately 800,000 cases per year are reported around the world[2]. In Brazil, there has been an increasing evolution of the suicide rate in recent years. Studies show that a percentage increase of approximately 30.0% between 1980 and 2006[10], reaching a mortality rate of 6.2/100,000 inhabitants in 2012 in the country[18], although there are variations of suicide rates among different Brazilian regions[10]. As for the Northern region, our results identified an average suicide mortality rate of 2.64±0.71/100,000 inhabitants. This result is lower than those found in the study by Lovisi *et al.*[10] (1980-2006) and in that of Marín-León *et al.*[19] (2004-2010) who identified, respectively, mortality rates of 3.4 and 4.6/100,000 inhabitants in the Northern region. However, it is noteworthy that the periods evaluated in these two studies[10,19] are different from those analyzed in herein (2008-2017). Furthermore, these two studies[10,19] used the Ministry of Health's Mortality Information System as a database, which is a different data source from the one used in the present study (BPSYs - state security secretariats). Thus, it is possible that data sources, although official, may present different patterns of notification and investigation of events.

Furthermore, in this study, there was no significant difference between the averages of mortality rates from suicide in the NREAp and in the state of Amapá, with a difference of only 0.01 between the means and 0.52 between the medians. Therefore, it can be inferred that mortality from suicide in Amapá is, as well as in the Northern region, lower than the national rates described in previous studies[10,19]. This proximity, between the average rates, may be associated with the similarities between the state of Amapá and the region in which it is located, as the socioeconomic, demographic, and health indicators have similar values, as well as the states being under the influence of the same guidelines promoting mental health and combating suicide[20,21].

Furthermore, in order to explain the lower suicide mortality rate in Amapá and in the Northern region, when compared to Brazil, especially considering the disparity between the development of the North region and the rest of the country[21], it is necessary to emphasize that several studies have associated the occurrence of suicides with local socioeconomic characteristics[10,18,22]. Although it is noteworthy that there is no consensus in the scientific literature on the direct influence of these characteristics on suicide rates[22], some studies indicate that factors such as unemployment, low educational level, and poverty could be associated, to some degree, with suicide[18.23].

Another factor that, in theory, can justify the lower mortality from suicide in the Northern region, as well as in the state of Amapá, is the characterization of the spatial distribution of the population, which presents itself as large clusters in metropolitan areas that coexist with low care coverage[24], because regions with large numbers of inhabitants may have more underreporting[25]. Moreover, the Northern region and especially Amapá are locations with lesser distribution of firearms, when compared to the rest of Brazil[26]. This lower diffusion may be related to lower suicide rates, as the use of firearms can be considered the method with the highest lethality to commit the act[4,27]. A man who lives in a household where there is a firearm has an approximately 10 times greater risk of committing suicide than a man who lives in a household without a firearm[9].

Despite the results of low suicide mortality rates found in the Northern region and in some of its states, when compared with other Brazilian

regions and states, and the implementation of Ordinance No. 1.876 in 2006[20] which instituted national guidelines for the prevention of suicide, it was observed herein that between 2008 and 2017 the states of Amazonas and Pará (the two most populous states in the region) and the Northern region as a whole, showed significant increasing trends in suicide rates. This result is in line with that of D'Eça *et al.*[3] which also demonstrated an increasing trend in suicide rates in the Northern region between 1996 and 2015. The increase in suicide rates in the Northern region may be, in part, related to the growing process of dissolution of indigenous culture that is permeated by the urbanization of this population, and is more exposed to poverty, violence, alcoholism, and depression[10,19]. Moreover, this is associated with the fact that this region, in the last IBGE censuses, showed an increase in the population of self-declared indigenous people[5]. In Brazil, between 2011 and 2015, indigenous suicide mortality was approximately three times higher than in the white population[4].

Furthermore, it was observed that the increasing trend in the suicide rate did not only occur in the Northern region. Historical analyses by Minayo et al. (1980-2006)[14], by D'Eça *et al.* (1996-2015)[3], and Cicogna *et al.* (2000-2015)[28] showed an increase in the suicide mortality rate in other Brazilian regions and in Brazil. Thus, it is possible that the increase in the suicide rate observed in this study may also be related to the expansion and perfecting of the reporting and notification systems, which has occurred throughout Brazil in recent years[29,30]. However, despite relevant improvements in health information systems, underreporting of suicide cases is still a problem, as evidenced in this study by the absence of cases in 2011 in Amapá and in 2017 in Roraima. Thus, it is noteworthy that notification is essential for the implementation of public policies for the prevention of suicide, since for the intervention to occur toward suicidal behavior it is necessary to identify the risk factors and the vulnerable population[8].

In this sense, the Ministry of Health, through Ordinance No. 1271 of 2014[31], included suicide attempts into the list of mandatory notification injuries. This measure aimed to identify the vulnerable individuals at risk of death, as people who have a history of suicide attempt have a higher mortality rate than the general population[32]. However, suicide attempts are more underreported than suicide itself[29,32]. It is believed that for each attempt recorded there are four others that were not reported[32]. Thus, the underreporting of suicide attempts, whether due to misclassification, the unavailability of a professional to carry out the reporting, the shame of the victim and/or their family members in declaring the intention of self-injury, or due to any other cause of a personal nature[2,29], can prevent the inclusion of individuals at high risk for suicide in surveillance and mental health programs, with a consequent decrease in survival and consequent increase in mortality rates.

CONCLUSION

The average mortality from suicide in the state of Amapá did not show a significant difference from the average mortality in the Northern region (NREAp). In addition, mortality data in Amapá did not fit well with any polynomial regression model, which did not allow for a temporal trend to be traced for the state. However, it was possible to identify significant increasing trends in mortality in the Northern region and in the states of Amazonas and Pará (the two most populous states in the region).

These three temporal growth trends in mortality, especially in the Northern region

as a whole, indicate that suicide prevention policies need to be strengthened, with special attention to the region's most vulnerable populations, such as the indigenous people. Thus, government investment in the mental health sector is required in addition to those already implemented, as well as in the control of the dissemination of firearms and the sale of pesticides. However, it is necessary to consider that part of this increase may be due to the improvement in reporting systems that took place over the period.

Finally, among the limitations of this study are underreporting, especially in the time-series for the states of Amapá and Roraima, and the consequent underestimation of suicide mortality rates. Furthermore the epidemiological profile of the victims was not described, which is important for the development/evolution of health strategies that face and prevent suicides. Thus, we suggest studies that minimize the underestimation of the suicide mortality rate and that describe the epidemiological profile of those affected in the Northern region and in the state of Amapá.

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