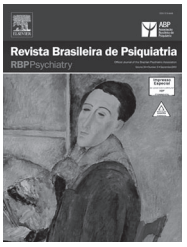
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ORIGINAL ARTICLE

Spatial distribution of suicide incidence rates in municipalities in the state of Espírito Santo (Brazil), 2003-2007: spatial analysis to identify risk areas

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DESCRIPTORS
Suicide;
Residence Characteristics;
Spatial Bayesian Analysis;
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Abstract
Objective: To analyze the spatial distribution of suicide incidence rate in a residential municipality of the state of Espírito Santo (ES), Brazil, from 2003 to 2007. *Methods:* Ecologic study of the exploratory kind, based on secondary data. Deaths per suicide, which took place in each municipality of ES, were included in the data according to information provided by the Mortality Information System. For the spatial data analysis, a Bayesian approach was used (Global empirical and Local Bayesian ones) to correct epidemiological rates. Moran's *I* index was calculated to a worldwide spatial level dependence, and Local Moran (LISA) to a local spatial correlation. The following software applications were used: Excel; R 2.6.2; SPSS 11.5 and TerraView 3.3.1. *Results:* The geographical localization of the municipalities that showed an incidence rate characterized as the average for suicide after adjustment (EBest Global) forms a corridor in the countryside. Some common characteristics among these municipalities are: a) immigration (Italians, Pomeranians/Germans); b) rural population (average of 53%); c) supporting economy (agriculture, husbandry and livestock). A global and local spatial correlation was found among the municipalities ($p < 0.05$). *Conclusion:* The study identified the spatial context where the greatest death incidence rate per suicide occurred in the state of ES, during the mentioned period.

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DESCRITORES:
Suicídio;
Distribuição espacial da população;
Analise espacial bayesiana;
Análise estatística;
Incidência.

Distribuição especial das taxas de incidência de suicídio nos municípios do Estado do Espírito Santo (Brasil), no período de 2003 a 2007

Resumo
Objetivo: Analisar a distribuição espacial das taxas de incidência de suicídio segundo o município de residência no estado do Espírito Santo (2003 a 2007). *Métodos:* Estudo ecológico do tipo exploratório, baseado em dados secundários. Foram incluídos os óbitos por suicídio ocorridos no período, em cada um dos municípios do Estado, conforme o Sistema de Informação sobre Mortalidade. Para análise espacial dos dados, utilizou-se a abordagem bayesiana (Bayesianos Empírico Global e Local) para correção de taxas epidemiológicas. Calculou-se o índice *I* de Moran, para dependência espacial em nível global, e o Moran Local (LISA), para correlação espacial local. Foram utilizados os seguintes programas: Excel; R 2.6.2; SPSS 11.5 e TerraView 3.3.1. *Resultados:* A localização geográfica dos municípios que apresentaram taxa de incidência classificada como média para o suicídio após ajuste (EBest Global) forma um corredor localizado no interior do estado. Algumas características comuns a esses municípios são: a) imigração (italianos e pomerânios/alemães); b) população rural (média 53%); c) base econômica (agricultura, pecuária ou agropecuária). Encontrou-se correlação espacial global e local entre os municípios ($p < 0,05$). *Conclusão:* Identificou-se o contexto espacial onde ocorreram as maiores taxas de incidência dos óbitos por suicídio no estado do Espírito Santo, durante o período.

Introduction

Suicide is a complex phenomenon associated with multiple factors varying according to time and space. Among the top ten causes of death of individuals of all ages in the world, suicide is a major public health problem.[1] More people die by suicide than in all armed conflicts and, in many countries, the number of suicide deaths is equal to or greater than the number of deaths by traffic accidents.[2]

The uneven geographical distribution of suicide has persisted throughout time, both between and within countries, which led to the hypothesis that suicide is correlated to the area level.[3] Some studies show that geographical aspects can be directly related to the increase in suicide rates. One example is the observation that individuals in rural areas seem to be more likely to attempt suicide compared to those living in urban areas.[4] And, despite the controversies, we can see that geographical and cultural factors related to suicide statistics are important enough to develop macro-analyzed, multifaceted explanations for the main evidences of the causes of this phenomenon.[5]

In light of this picture, this study aims to analyze the spatial distribution of suicide incidence rates according to municipality of residence in the state of Espírito Santo between 2003 and 2007. Identifying this association will allow us to compare the suicide phenomenon in this state to other Brazilian and international studies, which will contribute to both understanding the phenomenon and focusing on prevention strategies.

Methods

This is an ecological exploratory study based on secondary data that has the municipalities of the state of Espírito Santo as analysis units.

Espírito Santo (capital city: Vitória) has 78 municipalities, which are divided into 4 macro-regions and 12 micro-regions. The state is part of Brazil's Southeastern Region and is bordered by: North: state of Bahia; East: the Atlantic Ocean; South: state of Rio de Janeiro; and West: state of Minas Gerais. Espirito Santo's colonization was mainly German and Italian, but also Portuguese, Dutch and Polish. It has a 46,077.5 km^2 area, corresponding to 0.54% of the Brazilian territory. The estimated resident population for 2009 is of 3,487,199 inhabitants.[6,7]

This analysis included the death by suicide data (X60-X84) occurring between 2003 and 2007 in each of the municipalities in the state of Espírito Santo. These data were recorded and made available in the Mortality Information System (SIM), obtained from the IT Department of the Brazilian Unified Health System (DATASUS) of the Brazilian Ministry of Health. Population estimation data were obtained from the Brazilian Institute of Geography and Statistics (IBGE), which were also available on DATASUS.[8]

The study's time period (last five years) was chosen because it is enough time to analyze what this investigation proposes. Furthermore, suicide is considered a "rare" event, and it is therefore subject to higher variability in longer periods. Thus, the longer the period of time, the lower the data fluctuate.

In order to calculate the incidence rates of suicide mortality in the municipalities of Espírito Santo within the study period (2003 to 2007), the number for this type of death, the population for each year, and the municipality were entered into R 2.6.2 software. Due to the non-availability of a current map of Espírito Santo, with its 78 municipalities, we used the latest available version, made up of 77 municipalities (in which Governador Lindenberg and Colatina were still one). The gross incidence rate was calculated by dividing the sum

of the deaths in the five years analyzed by the sum of the populations in this period of time (population number in July of each year) multiplied by 100,000.

In order to analyze the spatial data, the Bayesian approach was used (Global and Local Empirical Bayes' Estimators) for correcting epidemiological rates. This analysis allows the elimination of random fluctuations of the rates. The Local Empirical Bayes Estimator is a rate adjusted as:

$$b_i = w_i + t_i + (1-w_i)m$$

In which t_i is the risk rate or child mortality rate in the area, m is the global rate for the State of Espírito Santo, and w_i is the weight between 0 and 1 that depends on the size of the population in area i. The bigger the population in area I, the closer 1 is to w_i, which means that in areas where the population is bigger, empirical Bayes estimation is very close to t_i. In areas with a small population, the value of b_i will be intermediate between t_i and m.[9]

After that, the spatial correlations of child mortality coefficients and municipality components were analyzed. From this analysis, it was possible to determine whether the spatial distribution of mortality rate happens at random or if it follows some pattern of occurrence in space. For this purpose, Global Moran's I and Local Moran Index (LISA) were calculated taking into account that significance values that are lower than 0.05 delimit the areas in which there are local child mortality spatial structures.[10]
Moran Index is given by:

$$I = \frac{n \sum_{i \neq j} W_{ij}(Y_i - \bar{Y})(Y_j - \bar{Y})}{S_0 \sum_{i=j} (Y_i - \bar{Y})^2}$$

$$S_0 = \sum_{i \neq j} w_{ij.}$$

Symbols Y1, Y2, Yn are random variables measured in n areas; W_{ij} are measures of the weight matrix W. When I value is close to zero, we can conclude that there is little spatial correlation, i.e. it indicates weak or null spatial dependence. When there are positive values of I, there are indications of spatial dependence. Negative I values are rare.[10]

LISA indicator is expressed by the following formula[10]:

$$I_i = \sum_{j=1}^{n} w_{ij} z_j z_i / \sum^{n} z_j^2 \qquad (1.2)$$

The statistics calculated for the LISA index is computed in a similar way to that of global Moran's I, in which Z is the variable y standardized by the mean. Therefore, the respective values should be checked for significance < 0.05. In order to detect significance, the visualization tool using significance map LISA is used, in which the significant associations are mapped and highlighted ($p < 0.05$).[10]

The analysis was implemented by using the following software programs for generating map, rate calculations and indexes: Excel; R 2.6.2; SPSS 11.5 and TerraView 3.3.1

As far as ethical aspects are concerned, it is important to note that the whole research process was carried out in compliance with Resolution n# 196/96 of the National Health Board (Conselho Nacional de Saúde - CNS), and the project was approved by the Ethics and Research Committee of the Univresidade Federal do Espírito Santo under n# 159/09.

Results

In the study period (2003 to 2007), there were 760 deaths by suicide in the State of Espírito Santo, which represented a mean coefficient of 4.5 per 100,000 inhabitants – considered a low incidence.

Of all the deaths, 76% of the victims were male, with higher incidence between ages 10 and 49 (70.6%). As far as ethnicity is concerned, even though some data are unknown (21.4%), 39.6% were Caucasian; 33.3% multiracial; and 5.6% Afrodescendant. As for educational background, the paucity of data is surprising (78.5% unknown). Regarding the marital status variable, 38.8% were married, 38.1% single, 7.5% divorced, and 3.1% widowed. Among the suicide methods used, the five ones standing out in the study period were, sequentially: X70 (hanging, strangling, and choking lesions), 45.39% of the cases; X69 (autointoxication and intentional exposure to other non-specified chemical products and harmful substances), 11.8% of the cases; X74 (gunshot and non-specified gunshot lesions), 11.3% of the cases; X68 (autointoxication and intentional exposure to pesticides), 7.1% of the cases; and X80 (lesion from jumping off heights), 5.4%. These data are shown in Table 1.

The incidence rates of suicide cases were calculated per 100,000 inhabitants, the rates were corrected using the Global and Local Empirical Bayes Methods (GEBayes and LEBayes, respectively). Table 2 shows the descriptive statistics of the rates of death by suicide taking place in the study period for both gross and corrected data. The mean gross rate was 5.5 per 100,000 inhabitants, and this number drops to 4.8 per 100,000 inhabitants when the rate is corrected by the global method. It is also seen that the maximum value drops from 18.28 for the gross rate (Itarana) to 13.37 for local rate, and down to 10.24 for the global rate (both in the municipality of Santa Maria de Jetibá).

Figure 1 shows the coefficient of death by suicide, its components, and respective local and global Bayesian transformations for each municipality in the state of Espírito Santo between 2003 and 2007. The darker grey shades in the map represent the highest rates of mortality coefficient.

The following scale was used for categorizing the suicide coefficients: low coefficient, when less than 5/100,000; medium, between 5 and 15/100,000; high, between 15 and 30/100,000; and very high, when greater than 30/100,000.[11,12]

The first map, which refers to the gross rate, shows that, of the 77 municipalities, 43 (55.9%) have coefficients of less than 4.9/100,000 inhabitants; 32 (41.5%) between 5 and 14.9/100,000 inhabitants; and 2 (2.6%) between 15 and 29.9/100,000 inhabitants. Among the municipalities in ES, no coefficient greater than 29.9/100,000 inhabitants was observed.

The second map shows that the local rate has adjusted gross rates to lower values in the municipality of Itarana (from 18.3 to 9.2) and Irupi (from 16.6 to 8.4). The same happens to many countryside municipalities, whose neighbors had higher rates (Mucurici; Ponto Belo; Barra de São Francisco; São Roque do Canaã; Itaguaçu; Laranja da Terra; Brejetuba; Ibatiba; Marechal Floriano).

On the other hand, the map with global rates shows the same pattern as the map with gross rates. It simply smoothes the rates of municipalities with the highest gross rates (Itarana e Irupi) and other municipalities that have already

Table 1 Percentage of deaths by suicide according to the variables age group, gender, ethnicity, educational background, marital status, and methods for the state of Espírito Santo, between 2003 and 2007

Variables	Categories	%
Age Group	10 to 14 years old	1.45
	15 to 19 years old	6.18
	20 to 29 years old	19.87
	30 to 39 years old	21.84
	40 to 49 years old	21.32
	50 to 59 years old	15.26
	60 to 69 years old	6.97
	70 to 79 years old	5.00
	80 years old or more	1.58
Gender	Male	76.05
	Female	23.95
Ethnicity	White:	39.61
	Black	5.66
	Multiracial	33.29
	Unknown	21.45
Educational background	None	1.84
	1 to 3 years	4.87
	4 to 7 years	8.68
	8 to 11 years	3.16
	12 years old or more	2.89
	Unknown	78.55
Marital status	Single	38.16
	Married	38.82
	Widowed	3.16
	Divorced	7.50
	Other	0.39
	Unknown	11.97
Method (five most commonly used)	X68 Self-poisoning with pesticides	7.11
	X69 Self-poisoning with other chemicals NE	11.84
	X70 Lesion by self-hanging, strangling, choking	45.39
	X74 Lesion by self-inflicted gunshot and NE	11.32
	X80 Lesion by jumping off heights	5.39

shown medium and low averages (Marilândia; Vargem Alta; Jerônimo Monteiro; São José do Calçado; Guaçuí and Bom Jesus do Norte).

Figure 2 shows dispersion graphs referring to the Bayesian correction between gross rate and Local and Global EBest, respectively. It was possible to notice some discrepancy between the suicide data in some municipalities. In the Local EBest, the data of some municipalities have been smoothed (Atílio Vivacqua; Fundão; Vila Valério; Irupi and Itarana), whereas others (Santa Maria de Jetibá; Ponto Belo and São Roque do Canaã) have increased. Thus, the arrangement of municipalities in relation to regression line is one of dispersion. For Global EBest, the data for municipalities such as Fundão, Vila Valério, Santa Maria de Jetibá, Irupi, and Itarana are also smoothed, whereas for others such as São Roque do Canaã, the data increased. However, differently from what occurred with the Local EBest, the arrangement of the municipalities in relation to the regression line has lower dispersion.

We observed that the geographical location of municipalities with the incidence rate adjusted by Global Ebest and categorized as medium form an "aisle" located in the countryside, bordering mainly the states of Minas Gerais and Rio de Janeiro. An interesting fact is that these municipalities are all interconnected from north to northwest, with two groups of municipalities in the south of the state.

Some other characteristics of the municipalities with incidences categorized as medium also stand out:

a. Immigration: of the 28 municipalities, 64.3% were colonized by Italians; 10.7% by Pomeranians/Germans; 3.6% by Polish; and the remaining 21.4% have no immigration records;
b. Population constitution: these municipalities have a rural population ranging from 16% (Fundão) to 82% (Santa Maria de Jetibá). On average, 53% of the population lives in rural areas;
c. Economic basis: all have their economy based mostly on agriculture (especially coffee) and/or animal husbandry.

Table 3 shows the results of the Monte-Carlo Empirical Simulation for Bayesian Estimation (Moran Index) of death by suicide taking place in the in the State of Espírito Santo, according to gross and adjusted data. The results show the existence of a significant spatial correlation (p = 0.001) for the Local and Global map (p = 0.011). Regarding gross rate, both local and global adjustments increased the spatial correlation coefficient, even though it was not very high, Moran Index equal to 0.17.

Table 2 Descriptive statistics of gross and estimate rates

Statistics	Gross Rate	Local EBest	Global EBest
Mean	5.533	5.293	4.869
Median	4.528	4.898	4.502
Standard deviation	3.411	2.110	1.524
Minimum	0.000	1.904	2.143
Maximum	18.289	13.377	10.243

Table 3 Monte-Carlo empirical simulation for Bayesian estimation - Moran Index

Incidences	Statistics	p-value
Gross incidence	0.1735	0.017
Local adjustment	0.3262	0.001
Global Adjustment	0.2076	0.011



Figure 1 Map of global rates according to Local and Global EBest analyses.

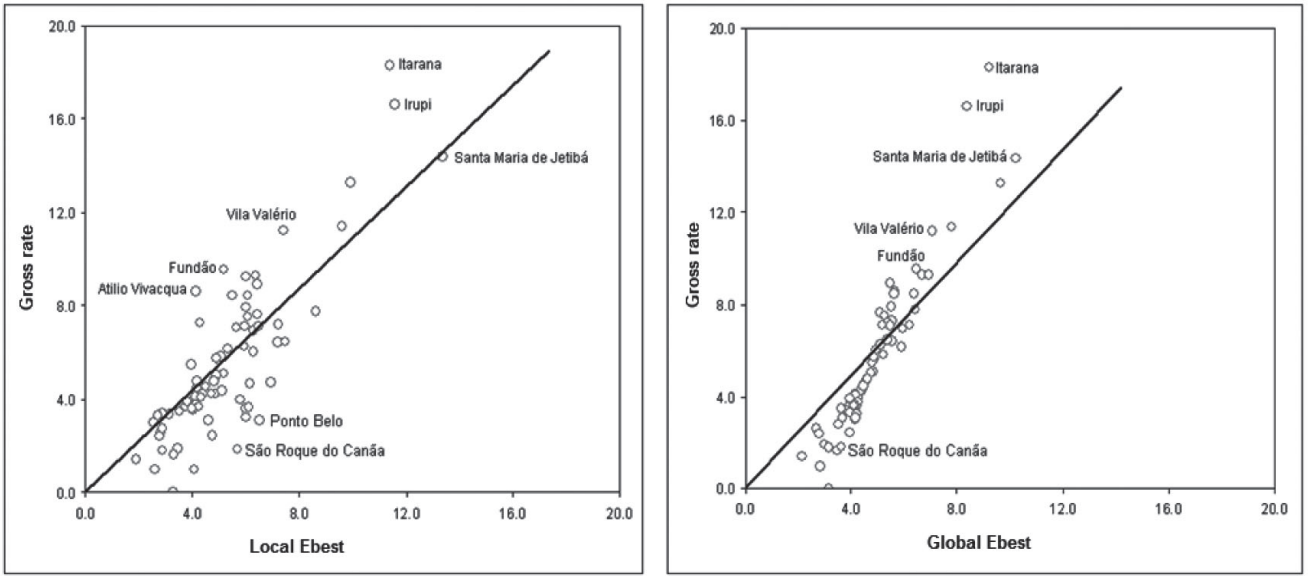


Figure 2 Dispersion Graph of gross rate corrected by Local and Global Bayes Methods (Local EBest and Global EBest), respectively, for Espírito Santo between 2003 and 2007.

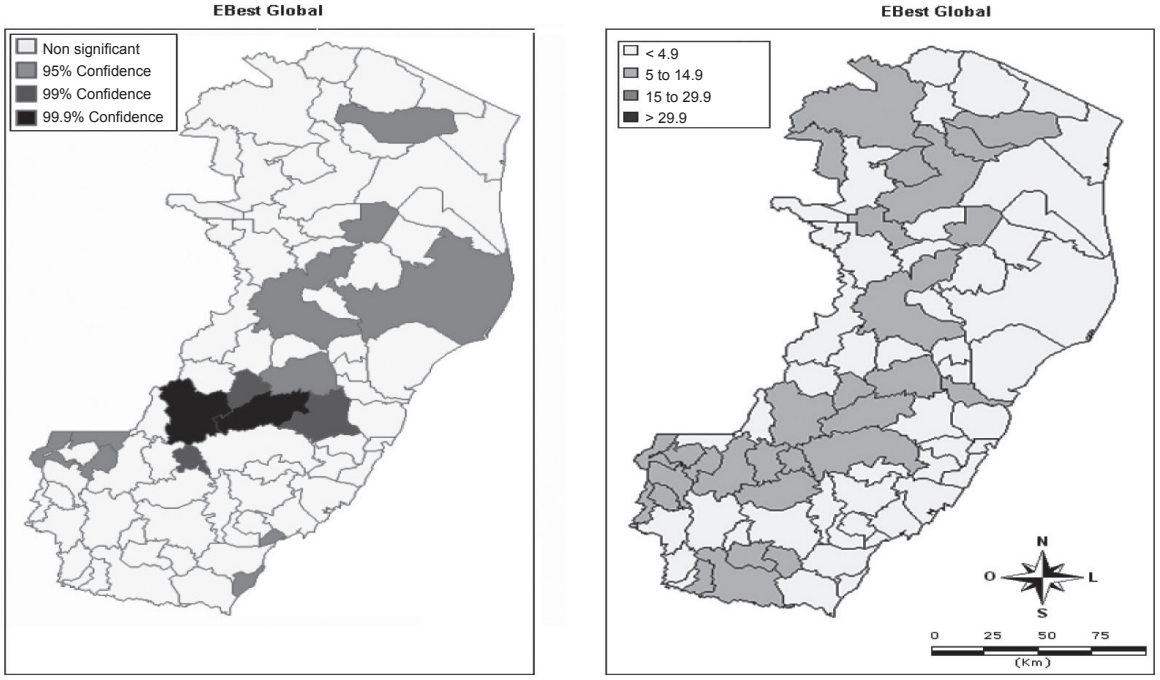


Figure 3 Spatial distributions of areas with significant spatial dependence and incidence among the municipalities in the state of Espírito Santo between 2003 and 2007.

Once the spatial dependence between rates was detected, we calculated the occurrence of local and different systems of occurrence of this phenomenon, using the Local Moran Index (LISA). Figure 3 shows the spatial distribution of this correlation for confidence levels over 95% (confidence of 95%, 99% and 99.9%) for rates adjusted by Global Ebest and the respective incidences calculated through this method.

The results indicate a spatial correlation with confidence of 99% between the municipalities of Venda Nova do Imigrante, Santa Leopoldina, and Itarana. The municipalities of Afonso Cláudio and Santa Maria de Jetibá showed correlation with confidence level of 99.9%. All these municipalities showed incidences categorized as medium, and they are located in the Macro Metropolitan Region of the State of Espírito Santo. The correlated municipalities at the confidence level of 95% (Pinheiros, Vila Valério, Colatina, Linhares, Santa Teresa, Piúma, Marataízes, Iúna, and Ibatiba) are spread over all the four macro-regions that make up the State of Espírito Santo.

Discussion

Since the late 1980s, new approaches in the health field, in which spatial location plays an important role, have been discussed and tried. Although these studies were initially going against the flow of the analytical models in epidemiology at the time (based on strictly individual approaches searching for risk factors for chronic diseases), a few years later, the role of the socio-cultural environment to determine disease began to gain importance.

The spatial analysis methods in the health field have mainly been used for ecological studies, in which the unit of analysis is a population or group of individuals usually belonging to a particular geographical area. These studies are often carried out combining databases of large populations; consequently, they are cheaper and faster compared to those involving the individual as an analysis unit. Ecological studies also aim at assessing how social and environmental settings can affect the health of population groups. In this case, measurements gathered at an individual level are able to show properly the processes occurring at a collective level.[13]

The main objectives of ecological studies are to indentify risk areas in relation to global means of the process studies, to seek factors to explain the differences in incidence found either in the field of exploratory analysis (mapping diseases) or in explanatory models (identifying risk differences) and to point toward preventive measures.[12] This has increasingly valued the analysis of geographical space distribution data in health management, because it shows new means to plan and assess actions based on the analysis of disease spatial distribution, location of health care services, and environmental risks, among others.

In the present study, the ecological approach is aimed at analyzing suicide data in municipalities in the State of Espírito Santo. However, some limitations that are inherent to this method should be highlighted: 1) In ecological studies, the unit of analysis is the population, not the individual. Thus, an important limitation in this study is that the relation between the two variables does not necessarily reflect the individuals' situation; 2) This delimitation can result in the so-called 'ecological fallacy', which is characterized by inappropriate generalization of features of an aggregate for the units that make it up. Another point to highlight is that the areas analyzed may have caused levels of heterogeneity deriving from particular characteristics of each municipality.[14] Despite these limitations, opting for an ecological study is due to the fact that this method offers an overview of the problem (ecological studies are admittedly useful for this

purpose);[14] it is little used for studies carried out in Brazil, especially in terms of suicide; and the results found can be compared to other studies and used by managers to implement public policies to face the serious problem of suicide.

The categorization of mortality by suicide data in the State of Espírito Santo regarding the variables gender (higher occurrence of suicide among men); age group (increase in the number of young people who commit suicide compared to the elderly); and ethnicity (higher prevalence of suicide among white people) are in compliance with the data in the relevant literature.[15] For the variable educational background, the data found followed the "unknown" pattern pointed out by the Brazilian Ministry of Health for 2003, with high percentage of unknown/blank information (two-digit figures).[16] As for marital status, the results (higher occurrence among married people, followed by single people) differ from the results of several other studies because, worldwide, most victims of suicide are single, divorced, or widowed.[17] As far as the suicide methods are concerned, the data comply with results of national studies, showing hanging as the most commonly adopted method for suicide in Brazil. However, the subsequent two most common methods are inverted. The relevant literature shows gunshots as the second most commonly used method, followed by exogenous poisoning.[18]

The smoothing process used in this study (global and Local EBest) allowed for a better estimation of suicide incidence rates in the municipalities of the state, using data from neighboring spatial units. This procedure is recommended because it reduces the influence of random fluctuation of measurements, favoring the production of more reliable maps, aside from allowing visualization of areas with the highest risks.[19] In this study, this adjustment showed to be adequate because it smoothed and favored a better presentation of incidence rates per municipality. Since the adjustment carried out using Global EBest was the closest one to the map of gross rates, we chose to use it as a parameter for discussion.

The mean coefficient of suicide for Espírito Santo in the study period (2003 to 2007) was equal to the Brazilian mean (4.5 per 100 thousand inhabitants). However, when analyzing its occurrence among the municipalities in the state, we verified that coefficients varied between less than 5/100,000 and 5 to 15/100,000. Mortality classification considers coefficients smaller than 5/100,000 as low; the ones between 5 and 15, medium; between 15 and 30, high; and those greater than 30, very high.[12,20] According to these criteria, suicide mortality in some municipalities in the State of Espírito Santo can be classified as having medium incidence and, in others, low incidence.

These medium incidence coefficients found after the adjustment (EBest Global) for some municipalities in the state of Espírito Santo differ from this state's average and are close, for example, to those found in the state of Rio Grande do Sul (average of 10.2/100,000 in the period between 1980 and1999), pointed as the state with the highest incidence of suicide in Brazil.[21] Through an outline and overview of suicide in WHO member-countries, we can see that the coefficients of suicide mortality vary between countries, and both high and low coefficients are found in almost every continent – the Americas, Asia, and Europe. By comparing the coefficients found in this present study (after global EBest adjustment) to those from other countries, we see that the municipalities with medium incidence are comparable to Argentina (8.7/100,000); Bosnia and Herzegovina (14.8/100,000); Canada (15.0/100,000); Chile (8.1/100,000); Hong Kong (14.9/100,000); Costa Rica (8.8/100,000); Ecuador (7.1/100,000); El Salvador (11.2/100,000); Georgia (5.3/100,000); Germany (14.3/100,000); Israel (8.7/100,000); Italy (8.4/100,000); Mexico (5.1/100,000); Nicaragua (7.6/100,000); and Panama (7.8/100,000), among others.[15]

As for geographical location of the municipalities with medium incidence rates after adjustment (EBest Global), it is seen that they form sort of an "aisle" located in the countryside of Espírito Santo. This result complies with the data presented by Waiselfisz,[22] who advocates the existence of a suicide trend moving towards the countryside. Also, according to WHO (2003), there is usually large disparity between suicide rates in urban and rural areas. WHO points to social isolation; more difficulty in detecting alert signs; limited access to physicians and healthcare services; as well as poor educational backgrounds as the possible reasons for suicide rates to be higher in many countryside areas.[15]

On the other hand, the results obtained by calculating the Moran Index expressed statistically significant autocorrelation, although not very strong. Moreover, the analysis of Global autocorrelation predictors showed the existence of spatial dependency, with confidence level of 99% for three municipalities (Venda Nova do Imigrante, Santa Leopoldina and Itarana), and confidence level of 99.9% for two municipalities (Afonso Cláudio and Santa Maria de Jetibá). These areas can then be considered as having high suicide risk. Another point to be highlighted is the fact that, except for Santa Leopoldina, all the other municipalities showed incidence rates classified as medium after EBest adjustment.

Both the municipalities presenting spatial correlation and those with suicide mortality coefficients classified as medium after Global EBest adjustment are, in most cases, characterized by Italian and Pomeranian/German immigration. It is interesting to note that most of these immigrants keep their homeland culture, habits, and typical festivals. Even nowadays, we can find those who just know how to speak the language of their ancestors, and those who only speak Portuguese when necessary, but outside family settings.

According to data from the relevant literature, deaths by suicide may differ between ethnic groups and between urban and rural areas. In addition, immigration is considered risk factor for suicide. The Pan American Health Organization report (2002)[23] points at this issue and shows that suicidal behavior rates among immigrants are similar to those in their country of origin, which suggests a strong influence of cultural aspects in these cases. The impact of immigration on suicide rates has been studied in countries such as Australia, Canada and The United States, where there are large numbers of ethnic groups. In these countries, the suicidal behavior rate found among some groups of immigrants seems to be similar to that recorded in their countries of origin, which shows the influence of cultural factors on this phenomenon.[15]

According to Baptista,[5] the areas made up of immigrants show higher numbers of suicides compared to other areas, suggesting that suicide could be explained by social isolation combined with other factors such as psychological disorder, and possible genetic and environmental exchanges deriving from their new habitat.

Viana et al.,[24] in a study aiming at describing and assessing suicide incidence among individuals from the Association of Municipalities in the Laguna Area (Amurel – *Associação dos Municípios da Região de Laguna*, state of Santa Catarina) between 2001 and 2005, verified that the coefficient of deaths by suicide varied a lot between all the 17 study cities, ranging from values as high as in countries with the highest rates in world to values lower than Brazilian estimates. The authors think that high rate of death by suicide in the area could be explained by the presence of European immigrants, who inherited the culture of their ancestors, making their death rate be close to those in Europe.

Another point to be highlighted in the present study concerns the fact that both the municipalities showing spatial correlation and those showing medium incidence rates after Global EBest adjustment are economically based on agricultural activity. Today, most of these municipalities still have a larger rural than urban population. Their main economic activity is agriculture and/or animal husbandry.[6] Coffee farming, the main activity of European immigrants (Italian and Pomeranian/German) in the state, is the most common activity in the municipalities identified. Coffee culture is characterized by the use of large amounts of agricultural inputs, among them, pesticides.[25]

Meneghel et al.,[21] in a study aiming at presenting epidemiological data on suicide in the state of Rio Grande do Sul (between 1980 and 1999), found that this Brazilian state has historically shown the highest suicide coefficients in this country, and that this fact has stimulated several investigations by researchers from various fields of knowledge. These studies point to ethnicity, culture, social crises, and even climatic aspects in the area as possible factors linked to the problem. These authors noticed that people working in agricultural, animal husbandry and fishing activities showed higher suicide mortality coefficients (almost three times higher).

Other recent studies have shown high incidence of suicide among farmers, especially in particular regions in the country where pesticides such as organophosphorates, harmful to human health, are used freely.[26] This situation deserves more specific studies, because Brazil is the third market and the eighth biggest consumer of pesticides per hectare in the world, and herbicides and insecticides are behind 60.0% of the products commercialized in this country.[27]

Conclusion

Space is, at the same time, product and producer of social and environmental distinction. This process has significant impact on the health of social groups comprised in the studies. In this regard, the spatial analysis of health conditions is an important instrument to assess the impact of social processes and structures on the determination of health events.[28] Understanding the spatial structure and dynamics of the population is the first step to characterize health situations, because the spatial analysis allows reestablishing the context in which the health event took place, contributing then to understanding the socio-environmental processes involved.[28] Incorporating the "space" category into health studies allows people to discuss about the differences between study areas and regions, as well as their relation to the spatial structure of which they are part.[29]

In sum, the present study allowed us to identify the spatial context in which the highest incidence rates of death by suicide occurred in the State of Espírito Santo between 2003 and 2007. This kind of investigation is extremely important because the identification of the areas with higher risk of suicide enables better planning of action/coping strategies, as well as control and allocation of resources earmarked for facing this serious public health issue.

Disclosures

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** Modest*
*** Significant*
**** Significant. Amounts given to the author's institution or to a colleague for research in which the author has participation, not directly to the author.*

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