Factors associated with suicide mortality among the elderly in Brazilian municipalities between 2005 and 2007

Fatores associados com a mortalidade por suicídio de idosos nos municípios brasileiros no período de 2005-2007

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Abstract *This scope of this paper was to conduct an ecological analysis of suicide mortality of people aged 60 years or more in Brazilian municipalities between 2005 and 2007, by investigating factors associated with the event. Data on suicide deaths were extracted from the Mortality Information System, codes X60 to X86 and Y87.0 (ICD-10). Poisson, negative binomial and zero-inflated negative binomial (ZINB) regression models were adjusted. The latter exhibited the best results when comparing models. The proportion of non-whites (negative association), the rate of hospitalization for mood disorders (positive association) and sex ratio (negative association) were identified as factors associated with suicide.*
Key words *Suicide, The elderly, Ecological study, Zero-inflated negative binomial regression model*

Resumo *Este trabalho teve como objetivo realizar análise ecológica sobre suicídio de pessoas com 60 anos ou mais nos municípios brasileiros no triênio 2005-2007, investigando-se fatores associados ao evento. Foram utilizados dados referentes aos óbitos por suicídio extraídos do Sistema de Informação sobre Mortalidade (SIM), códigos X60 a X86 e Y87.0 (CID-10). Foram ajustados modelos de regressão de Poisson, binomial negativa e binomial negativa inflacionada de zeros (ZINB). Este último exibiu os melhores resultados quando da comparação de modelos. Foram identificados como fatores associados ao suicídio: proporção de não brancos (associação negativa), taxa de internação por transtornos de humor (associação positiva) e razão de sexo (associação negativa).*
Palavras-chave *Suicídio, Idosos, Estudo ecológico, Regressão binomial negativa inflacionada de zeros*

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Introduction

Approximately one million people worldwide die of suicide each year, generating a global death rate of 16 deaths per 100,000 inhabitants. This is higher than deaths caused by war and homicide combined[1].

Additionally, in several countries worldwide elderly suicide has become a relevant public health problem, which has been intensifying with population ageing. World Health Organization data show that for men rates have gone from 19.2/100,000 inhabitants aged 15 to 24 to 55.4/100,000 inhabitants for men over 75 years old in 2000[2]. Recent studies have been showing differences in factors for the young elderly (younger than 75) and for older individuals (older than 75). In the United States in 1998 mortality by suicide among individuals older than 65 reached 18% and it is likely that this figure will reach 35% in 2030[3].

In Brazil in 2009 external causes (ICD-10 Chapter XX) ranked number seven in causes of death among people aged 60 or older, totaling 21,437 deaths. Of those, 1,378 were suicides. It should also be taken into account that 3,364 deaths in that year were classified according to codes Y10-Y34, that is, as events when it is not possible to distinguish between accidents, self-inflicted harm or assault because the action's intent is recorded as unknown.

According to Mitty and Flores[3], risk factors for elderly suicide may be classified according to the following categories: demographic, mental problems, physical discomfort and social problems. According to several authors, depression, social isolation, lack of a support network and loneliness, ideations and previous attempts, and access to the means are also reasons involved in risk for suicide[1,4,5]. Among social factors, several scholars mention the marital statuses of single, widow(er) or separated. Also considered as very important is experiencing stressful events, such as losing beloved family members, since those events interfere with psychological, psychiatric and biological factors in the elderly. Among psychosocial factors, alcoholism and use of other drugs are considered relevant[4,6,7].

Epidemiological studies about this topic have been demonstrating that suicide occurs more often among white individuals than non-whites in several countries[2,6,7]. Indigenous populations are an exception, since they are at high risk in different contexts[8,9]. The lack of mental health services, lack of psychiatric hospital beds and of professionals are all aspects related to the occur-rence of suicide among the elderly in many parts of the world[10].

According to the WHO, the issue of suicide has not been properly addressed by countries because they are unaware of the fact that it is a very important issue - however considered as taboo - in most societies. Only a few countries include suicide prevention among their priorities. The issue of death communication also needs substantial improvement, since suicide is highly under-recorded worldwide[2]. Prevention strategies also should be thought in multi-sector terms involving other sectors besides healthcare, such as education, labor, police, justice, religion, laws, politics, media[11].

In this paper we aim to present an ecological analysis of suicide in individuals aged 60 or older in Brazilian municipalities from 2005-2007. We investigate, from the epidemiological point of view, variables associated with the phenomenon.

Methods

Mortality data for 2005-2007 were gathered from the Mortality Information System (Sistema de Informação sobre Mortalidade - SIM); the following 10th Revised International Classification of Diseases (ICD-10) codes were used: X60 to X86 and Y87.0. Population estimates for the middle year in the period being analyzed (2006) were obtained from Brazil's Institute for Geography and Statistics (Fundação Instituto Brasileiro de Geografia e Estatística - IBGE)[12].

Based on a literature review about the subject[1-3,6,13-15] and on accessibility of municipal information we chose as independent variables: sex ratio in the elderly population (female/male), population percentages by skin color (proportion of non-whites), percentage of elderly individuals who share responsibility for the household and marital status (proportion of unmarried individuals), all extracted from the 2010 Census[16]; existence of special police stations for the elderly (yes/no) and presence of violence prevention centers (yes/no), both obtained from IBGE's Munic Survey (2009)[17]; and percentage of hospital admissions due to mood disorders throughout 2010, extracted from the Hospital Information System (Sistema de Informações Hospitalares - SIH). Those disorders include problems such as depression, manic disorder and bipolar affective disorders. We also employed as an explanatory variable the Firjan Municipal Development Index (Índice Firjan de Desenvolvi-

mento Municipal - IFDM) for 2007. This tool combines information about employment and income, education and health, generating an index whose result ranges from 0 to 1 (where 1 equals the highest development stage). The dependent variable used consisted of the number of deaths by suicide among people aged 60 or older, and that occurred from 2005 to 2007.

In order to verify variables associated with the outcome we used the following models: Poisson's regression, negative binomial and zero-inflated negative binomial (ZINB). Such models were chosen because they are recommended for count data (deaths by suicide)[18,19].

Poisson's model is the standard approach for analyzing this type of datum; however it assumes mean and variance are equal, which may not occur in series with overdispersion or excess zeros. Using Poisson's Regression in such situations leads to underestimating standard-errors of coefficients of regression models, generating confidence intervals that are too narrow and p-values that are too small.

An alternative to solve the overdispersion or excess zero problem in data is using negative binomial distribution. There is a change in its variance function that makes its dispersion parameter allow for an additional variation[19]. Another model that may be used in such situations is the zero-inflated regression model[19-21]. According to this model the mean structure is modified to allow excess zeros, which are then considered as coming from distinct processes, an inflated and a non-inflated one (inflated part and noninflated part). Models presume that there are two latent groups: the first one generates zeros only and the second generates a Poisson's distribution or negative binomial, which may take values greater than or equal to zero. Therefore, variables associated with each of those parts (inflated and noninflated) are included in the final model. The interest here lies in analyzing factors associated with the noninflated part.

In the modeling process we initially adjusted Poisson's regression models to each of the explanatory variables. Those which presented a general association with the answer variable with p-value $\leq$ 0.05 were included next in the negative binomial and ZINB regression models. Thus, model adjustment to verify associations between death by suicide and other variables followed the steps below: (1) bivariate analysis using Poisson's regression model; and (2) multivariate analysis using negative binomial regression and the ZINB model. Model selection was performed compar-

ing their log probability, in addition to assessing the number of zeros estimated by each one; this value was then compared with the amount of zeros actually observed. Municipalities' population data were included in regression models as an offset, using a logarithmic function.

Multicollinearity, that is, the existence of a linear correlation between independent variables[22], was verified. Based on this analysis we observed the association between variables: proportion of non-whites and IFDM, and thus we adjusted separate models using each of them.

To perform analyses we used the pscl[19] library of public domain software R 2.12.2[23].

Results

This study aimed at identifying variables associated with death by suicide in individuals aged or older in Brazilian cities, from 2005 to 2007.

Initial exploratory analysis demonstrated that nearly 70% of Brazilian municipalities did not record deaths by suicide in individuals aged 60 or older during the period analyzed. Of all 1,659 municipalities that recoded cases from 2005-2007, 30.1% were in the South, 28.9% in the Southeast and 28.5% in the Northeast. In the North and Middle-West regions 4.5% and 8.1% of municipalities, respectively, recorded at least one death by suicide in individuals aged 60 or older during that period. Table 1 shows the 16 municipalities that recorded over 15 deaths during that period. Among those there are nine capitals. The maximum number of deaths occurred in the city of São Paulo (SP). One also notices that three municipalities have less than 50,000 inhabitants: Venâncio Aires (19 deaths), Caxias do Sul (21 deaths) and Pelotas (23 deaths), and all of them are in the state of Rio Grande do Sul.

Initial analysis of independent variables has shown for sex ratio in the elderly population (female/male) an average of 1.1 women for each man, with municipalities showing a minimum ratio of 0.3 and others a maximum of 1.7. Half of the elderly population studied consists of unmarried individuals (mean = 0.5; SD = 0.9). The proportion of non-whites is on average 0.5 (SD = 0.2). The rate of admission for mood disorders ranged from 0.0 to 13.7 per 100,000 inhabitants, with a 0.2 mean. The percentage of elderly individuals who were co-responsible for households was, on average, 60%. As for the Firjan Index, we observed a 0.6 mean, 0.3 minimum and 0.7 maximum (Table 2). Only 34 municipal-

ities (0.6%) have special police stations for the elderly and 68 (1.2%) have Violence Prevention Centers.

Table 3 shows the final model selected, which includes the following variables: a) noninflated part: proportion of non-whites, rate of admission for mood disorders and sex ratio; b) inflated part: proportion of non-whites and sex ratio. That same table shows that in the noninflated part the variables proportion of non-whites and sex ratio showed negative coefficients, indicating that women and people whose color skin is black, brown, yellow/indigenous commit suicide less often than white individuals and men. The rate of admissions for mood disorders showed a positive coefficient, and this factor is positively associated with the occurrence of suicide. As for the part related to excess zeros, we verified that the variable proportion of non-whites had a positive coefficient and the variable sex ratio had a negative one.

Discussion

With this study we aimed to identify factors associated with the occurrence of suicide in elderly individuals in Brazilian municipalities. The modeling process has shown that the ZINB model better allowed for excess zeros in the series and

Table 1. Brazilian cities with more than 15 deaths by suicide in people aged 60 years or more, 2005-2007.

Region	State	Municipality	Deaths 2005-2007	Population* 2006
Southeast	SP	Campinas	16	101.152
Southeast	SP	Guarulhos	16	72.991
South	RS	Venâncio Aires	19	7.768
South	RS	Caxias do Sul	21	34.502
Northeast	PE	Recife	22	142.179
Southeast	SP	Santos	22	65.261
South	RS	Pelotas	23	40.953
Middle-West	GO	Goiânia	24	85.064
Northeast	BA	Salvador	24	183.400
Middle-West	DF	Brasília	30	127.418
Southeast	MG	Belo Horizonte	35	219.322
South	PR	Curitiba	35	150.560
South	RS	Porto Alegre	46	170.021
Northeast	CE	Fortaleza	49	180.846
Southeast	RJ	Rio de Janeiro	98	787.404
Southeast	SP	São Paulo	205	1.026.470

* Population aged 60 or older

Table 2. Descriptive measures of the independent variables used in data modeling.

Variable	Mean	Median	Minimum	Maximum	Standard Deviation
Sex ratio	1,1	1,1	0,3	1,7	0,2
IFDM	0,6	0,6	0,3	0,9	0,1
Proportion of unmarried individuals	0,5	0,5	0,1	0,9	0,9
Proportion of non-whites	0,5	0,5	0,0	0,9	0,2
Rate of admissions for mood disorders (100,000 inhabitants)	0,2	0,0	0,0	13,7	0,6
Percentage of elderly individuals who share responsibility for a household	0,6	0,6	0,4	0,7	0,04

Table 3. Variables associated with suicide deaths in people aged 60 or over (ZINB Model), 2005-2007

Variable	β (standard error)	p-value	RP*
Noninflated Part			
Proportion of non-whites	-1,62 (1,00)	0,000	0,20
Rate of admission for mood disorders	0,11 (0,04)	0,002	1,12
Sex ratio	-0,88 (0,14)	0,000	0,41
Inflated Part			
Proportion of non-whites	42,2 (14,5)	0,003	2,12E+18
Sex ratio	-13,8 (3,2)	0,000	1,02E-06

* Prevalence ratio

because of this it was chosen as the phenomenon's best explanatory model.

The negative coefficient found for the variable sex ratio is supported by literature findings which point to a higher occurrence among men[24-26]. The adjusted model also resulted in a negative coefficient for the variable proportion of non-whites, thus indicating that there is greater occurrence of suicide among white elderly individuals in Brazilian municipalities. There are examples in other studies that single out white or Caucasian populations as the ones with the highest occurrence of such events[2,13,26,27].

The issue of mood disorders has also been considered a relevant risk factor for elderly suicides, as widely documented in literature, especially depression[2,3,14,25,28,29]. Lack of openly and community-based mental health services which provide care to elderly individuals at risk of suicide has been noticed in many Brazilian municipalities, despite the National Mental Health Policy[30]. Such poor service may be related to the occurrence of suicides in this social group[10].

The variable IFDM, which shows a municipality's level of progress, has not proven to be associated with the outcome of suicide cases. Although it is not limited to the issue of economic development, the latter is included in items used to calculate this index. Literature and empirical study findings show that economic issues (such as financial crises and lowering of socioeconomic status) have proven to be related to suicide in elderly individuals[4,6].

The variable percentage of elderly individuals who share responsibility for a household was not associated with the occurrence of suicide. This datum deserves to be analyzed carefully, since municipal data under analysis do not allow us to make inferences about family composition in order to verify the association between living alone and suicide, an aspect mentioned in several studies[14]. If a variable had been obtained which included only elderly individuals exclusively responsible for a household, results might have been different.

Studies point to an association between being a widow(er) as a risk factor for suicide[6,25]. In this study we did not find any association between the variable marital status (proportion of unmarried individuals) and suicide. This may have occurred because the variable chosen to represent marital status (proportion of unmarried individuals) included the percentages for single and separated individuals and widows(ers), making it difficult to identify an association. A descriptive study conducted by Meneghel et al[6] using the population of Rio Grande do Sul showed higher coefficients of mortality by suicide among widows(ers).

A few factors have limited the reach of this study, above all the lack of municipal data about several aspects: access to means[15], alcohol and other substance abuse[3,25,31] and other information about self-destructive conduct[6]. The lack of municipal data about Brazil's elderly population also made it difficult to carry out the intended analysis. The modeling performed grouped different realities and incorporated all Brazilian municipalities. There are obviously factors common to all municipalities with large amounts of cases, which has been identified by the model. However, suicide is a complex phenomenon, it has multiple causes and certainly each municipality (or micro-region) has its own features. An analysis by micro-region, including municipalities with more similar realities, could provide important material to design prevention programs. Likewise, qualitative studies about psychosocial autopsies offer an invaluable contribution to local analyses.

Final Considerations

Risk factors for suicide in the elderly pointed out by this ecological study are known internationally, which facilitates prevention strategies already tested in several countries worldwide. Most of them are related to quality of life, to social support, to specific primary and secondary care and the area of mental healthcare, and the prevention of degenerative physical and mental conditions[11]. Strategies based on restricting access to means and permanent care being provided to the elderly who have ideations and who have attempted suicide have also shown to be effective reducing suicide rates. Several authors have been making contributions to all aspects mentioned in this paper, showing how warning signs for suicide among the elderly can be recognize and used to draft effective prevention proposals[3,11,15]. All such researchers have been showing through data that it is possible to prevent the end from coming too soon.

However the more general factors addressed here need to be further detailed by qualitative studies and treated in different levels. At a local scale, situational diagnosis should point out the most common factors, the presence or lack of social support and the existence and efficiency of

healthcare services. At the government level, above all in those where the phenomenon is more relevant, there needs to be coordination, municipal support and personnel training policies. At the national level, it is important that the issue of elderly suicide is treated as a relevant topic when organizing Violence Prevention Centers and in several attempts to improve notifications about violence and accidents.

However, one needs to bear in mind that ultimately all suicides have a component of individual choice, although this choice is influenced by social, psychological, environmental, medical and very painful circumstances. This is why all general factors need to be contextualized and reaching concrete cases. As Cassorla[32] shows, "there is no single cause of suicide. It is an event that occurs as the climax of a series of factors that build up in an individual's history; constitutional, environmental, cultural, biological and other problems come into play. What one refers to as "cause" is usually the final link in this chain".

We finish this paper by quoting the same author[32]: "I believe life should be lived here and now, with everything we can enjoy from it. And if we are not managing, something is happening. It is time for us to ask for help, even if we are not contemplating suicide. For unhappiness, not using one's potentials, not fighting for dignity may all be considered partial or micro-suicides".

Collaborators

LW Pinto and CMFP Silva participated equally in all stages of drafting this paper. TO Pires participated in data analysis. MCS Minayo, SG Assis participated in the discussion of results and drafting the paper.

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