Seasonality of suicide in the city of Sao Paulo, Brazil, 1979-2003

Sazonalidade do suicídio na cidade de São Paulo, Brasil, 1979-2003

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Abstract

*Objective: To evaluate suicide seasonality in the city of São Paulo within an urban area and tropical zone. **Method:** Suicides were evaluated using the chi-square test and analysis of variance (ANOVA) by comparing monthly, quarterly and half-yearly variations, differentiating by gender. Analyses of time series were carried out using the autocorrelation function and periodogram, while the significance level for seasonality was confirmed with the Fisher's test. **Results**: The suicides of the period between 1979 and 2003 numbered 11,434 cases. Differences were observed in suicides occurring in Spring and Autumn for the total sample (ANOVA: p-value = 0.01), and in the male sample (ANOVA: p-value = 0.02). For the analysis of time series, seasonality was significant only for the period of 7 months in the male sample (p-value = 0.04). **Discussion**: In this study, no significant seasonal differences were observed in the occurrences of suicides, with the exception of the male sample. The differences observed did not correspond with the pattern described in studies carried out in temperate zones. Some of the climatic particularities of the tropical zone might explain the atypical pattern of seasonality of suicides found in large populations within an urban area and tropical zone.*

Descriptors: Suicide; Time series; Male; Brazil; Tropical zone

Resumo

*Objetivo: Avaliar a sazonalidade do suicídio na cidade de São Paulo, uma área urbana em zona tropical. **Método:** Os suicídios foram avaliados pelo teste de qui-quadrado e análise de variância (ANOVA), comparando variações mensais, trimestrais e semestrais, diferenciando por gênero. Também foi realizada a análise de séries temporais, utilizando a função de autocorrelação e periodograma, além da confirmação, com o teste de Fisher de significância para sazonalidade. **Resultados:** Os suicídios do período entre 1979 e 2003 totalizaram 11.434 casos. Foram observadas diferenças apenas nos suicídios ocorridos na primavera e outono na amostra total (ANOVA: p-valor = 0,01), e na amostra para o sexo masculino (ANOVA: p-valor = 0,02). Pela análise de séries temporais, a sazonalidade foi significativa apenas para o período de sete meses, na amostra para o sexo masculino (p-valor = 0,04). **Discussão**: Neste estudo não foram observadas diferenças sazonais significativas na ocorrência de suicídios, com exceção da amostra masculina. Tais diferenças não correspondem ao padrão descrito nos estudos realizados em zona temperada. Algumas das particularidades climáticas da zona tropical poderiam explicar o padrão atípico de sazonalidades de suicídios em uma grande população de área urbana e zona tropical.*

Descritores: Suicídio; Séries temporais; Masculino; Brasil; Zona tropical

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Introduction

Seasonal variation of suicide occurrence has been studied for over 150 years.[1] Most of the studies have grouped the cases of suicide into seasons of the year and checked if there were differences between these groups. The distribution of the suicide cases during the year is deemed seasonal when a significant difference is found.

Almost all the studies carried out to date have been conducted in the Northern hemisphere and temperate zones. The seasonality is clearly determined by male gender. In these studies, the highest rates of suicide took place in the hot seasons, with the peak in Spring followed by Summer with the lowest rate in Winter followed by Autumn. Studies in the Southern hemisphere include an analysis in South Africa, a country located in a climatic temperate zone, where seasonal variation was observed in the occurrence of suicides.[2] Similarly, in South America, a study was carried out in the city of Santiago, Chile, where again a seasonal pattern was found in the rates of suicide.[3]

The mechanism underlying seasonality is not yet known. Some hypotheses have been proposed to explain this phenomenon. One such explanation considers the hypothesis of the climatic/meteorological factor influencing biological factors sensitive to the variation of the seasons of the year. For instance, it is known that the production of serotonin is directly connected with the daily hours of sunshine.[4] Serotonin, in turn, is connected with cases of depression and violent suicide.[5] Deisenhammer revised 27 studies in which suicide was associated with meteorological factors.[6] The author concluded that the most important factors associated with suicide were high temperature readings and greater hours of solar exposure. Another hypothesis considers socioeconomic and cultural factors that also showed seasonal variations.

Suicide has been linked to socioeconomic, genetic, psychodynamic, existential-philosophical and environmental factors.[7] Approximately 90% of those committing suicide probably had an underlying mental disorder.[8] In order to better understand the range of factors that lead to suicide, it is important to evaluate new hypotheses that could help toward improving prevention programs of this significant public health problem.

The city of São Paulo is located at a latitude of 23° 21' and longitude of 46° 44', near the Tropic of Capricorn, within the tropical climate zone. The city is situated at an approximate altitude of 720 to 850 meters above sea level. São Paulo constitutes a mega-metropolis that has a high degree of urbanization and had an estimated population in the year of 2005 of 10,927,985, making it one of the biggest cities in the world.

It is known that the seasonality of suicide is less prominent in more built-up areas.[2,9] The tropical climate and urbanization are two important aspects that express a characteristic trait of this study. The seasonality of the climatic attributes in temperate zones differs from tropical zones. In the temperate zone, the four seasons of the year are well-defined, but in the city of São Paulo seasons typically alternate between hot and humid (Spring and Summer), and cold and relatively dry (Autumn and Winter).[10]

Method

The cases of suicide for males and females in the city of São Paulo from 1996 to 2003 were obtained from the *Programa de Aprimoramento das Informações de Mortalidade*[11] (PRO-AIM - Death Records Improvement Program), available on the Internet, while data for the period spanning from 1979 to 1996 were obtained through the *Fundação Sistema Estadual de Análise de Dados*[12] (SEADE - State Data Analysis System). The data of the PRO-AIM and those of the SEADE are official records of monthly mortality. For the analysis by seasons of the year, the months were grouped as follows: Summer (January – February – March), Autumn (April – May – June), Winter (July – August – September), Spring (October – November – December).

The chi-square test and analysis of variance (ANOVA) were used for monthly and quarterly statistic analysis. In cases of significant difference (p-value < 0.05), multiple comparison analysis was carried out using the Bonferroni method. The analysis of homogeneity of variance was performed with the Levene test. The analysis was performed for the total series, and separately for the series of males and females.

To check for the existence of seasonality in the number of suicides for male, female and total, a periodogram analysis of time series was used, followed by Fisher's test for confirmation. A 5% level of significance was adopted. The Fisher's test for seasonality is different from the Fisher's Exact test, which checks independence between characteristics. The chi-square test also evaluates independence between variables and the Yates correction is valid when the sample is not so large. Since this study checked seasonality and not association, the Fisher's test for seasonality is the most appropriate.

Results

Over the period spanning from 1979 to 2003, a total of 11,434 cases of suicide were recorded. This total comprised 8,638 males and 3,112 females, yielding a male to female ratio of 2.77. The mean annual rate of suicide cases for the period was 4.44 per 100,000 inhabitants.

The analysis of variance (ANOVA) was divided into three parts: analysis by month, analysis by seasons of the year, and analysis by six-month period. The analysis was performed for total population, male and female samples.

1. Analysis of the total series of suicides by month

No statistically significant differences were observed (p-value > 0.05) in the mean number of monthly suicides, for the total sample [ANOVA: p-value = 0.076 (F = 1.696; gl = 11/288; Levene Test: p-value = 0.595)], the group of males [ANOVA: p-value = 0.360 (F = 1.101, df = 11/288); Levene test: p-value = 0.360] or for the group of females [ANOVA: p-value = 0.323 (F = 1.149, df = 11/288); Levene test: p-value = 0.087].

2. Analysis by seasons

1) Analysis of the total series of suicides by season

In this case, a statistically significant difference was observed (p < 0.05) in the mean number of suicides by season [ANOVA: p-value = 0.006 (F = 4.233, df = 3/296); Levene test: p-value = 0.555]. The results of multiple comparisons revealed a difference only when comparing Autumn with Spring (p = 0.003), where the mean number of suicides in Spring proved significantly higher (Figure 1).

2) Analysis of the series of male suicides by season

In this case, a statistically significant difference was observed (p < 0.05) in the mean number of male suicides by season [ANOVA: p-value = 0.022 (F = 3.269, df = 3/296); Levene test: p-value = 0.422]. The results of multiple comparisons revealed that difference only in the comparison between Autumn and Spring (p-value = 0.019). The mean number of suicides in Spring was significantly higher than in Autumn.
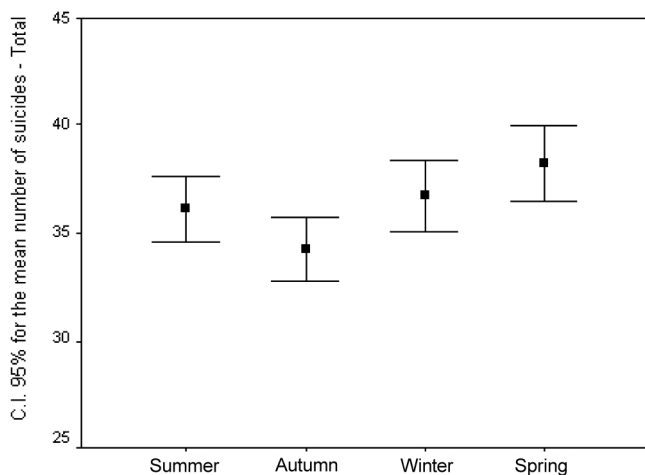
Figure 1 – Mean number of suicides by season in the city of São Paulo – total sample (1979-2003)

3) Analysis of the series of female suicides by season

In this case, no statistically significant difference was observed (p < 0.05) in the mean number of female suicides by season [ANOVA: p-value = 0.292 (F = 1.251, df = 3/296); Levene test: p-value = 0.162].

4) Chi-square test

The chi-square test was performed only for the season analysis. There were significant differences between the seasons for the total sample (X^2 = 8.8183; p = 0.042) and for the male sample (X^2 = 14.487; p = 0.002), whilst no such differences were observed between the seasons for the female sample (X^2 = 4.5127; p = 0.211).

3. Analysis of time series

A sharp drop in suicide cases was observed in 1986, most likely attributable to data collection errors. For a more coherent analysis, the data referring to 1986 were based on generation of random variables with Poisson distribution. The parameter of the distribution was the mean of the series. The whole subsequent analysis was carried out for each of the two samples (original and corrected), without relevant differences in the results obtained.

To improve identification of the data pattern with regard to seasonality, the periodogram graph of the original series of the total number of suicides was generated (Figure 2).

The three main peaks on the graph (Figure 2) indicate possible periodicities of the series. The graph shows peaks at 162, 24 and 36 months in increasing order of frequency. To verify if these peaks correspond with the periodicities, it is necessary to carry out appropriate tests of hypotheses. Within the scope of the present study, these possible periodicities have no scientific meaning, since its aim was to observe patterns of alteration of the series over periods of less than 1 year, for example, effects by month, season and six-month period.

The periodogram for the original series of male suicides (Figure 3) depicts three main peaks, which represent periodicities at 162, 12 and 7 months. Of these points, the 12- and 7-month lags could represent a seasonal period of increased suicide, although they did not present the biggest difference.

To check if these peaks were significant, the specific test of hypotheses was applied, namely the Fisher's test for seasonality.[13] The test showed significance only for the period of 7 months
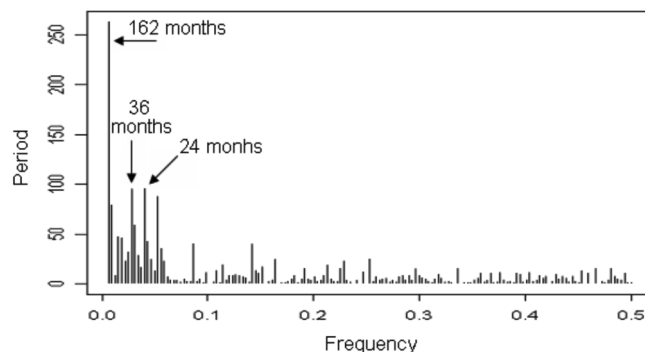

Figure 2 – Periodogram for the original series of the total number of suicides

(p = 0.04). This result can be considered a six-month period seasonal pattern.

The periodogram of the original series for females produced three main peaks indicating possible periodicities of the series corresponding to 162, 108 and 46 months in ascending order of frequency. These possible periodicities were meaningless in the scope of the present study, whose aim was to observe effects of alteration of the series over periods of less than 1 year.

Discussion

The suicide rates in the city of São Paulo were higher compared with rates found for the city of Campinas (1.1 *vs.* 4.1/100 000), in the period from 1976 to 2001,[14] and for the Brazilian general population (3.0 to 4.0/100,000) over the period from 1980 to 2000.[15] These rates were lower than 5.0/100,000[16] and can, therefore, be considered low compared with worldwide rates.

The analyses carried out using the chi-square test and ANOVA showed a difference between the number of suicides in Autumn and Spring, both in the total and male samples. However, in the female sample, this difference was not observed. The analysis by time series yielded significant results only for the period of 7 months in the male sample, using the Fisher's test (p = 0.04), with six-month period seasonal pattern. However these results do not correspond with the usual pattern of annual seasonality noted in studies in temperate zones, where differences occur between Winter and Spring/Summer. This result might be explained by climatic peculiarities of the tropical zone, or the high degree of urbanization of our population, as well as possible social and economic factors, such as the holiday period (January and July). This study design did not investigate the impact
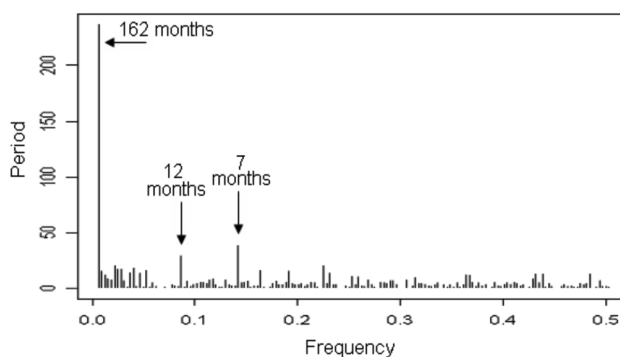

Figure 3 – Periodogram for the original series of male suicides

of the urban environment on the risk of suicide, due to the lack of a suitable comparator that, in this case, would be the analysis of the suicide rates in a rural environment of a tropical area.

A study carried out in Brazil investigated suicide seasonality across several States between 1979 and 1990. Single cosinor analyses were used with periods of 12 and 6 months for monthly series split by gender. A significant peak was identified in Spring and early Summer for males and females in the South of the country only (States: Paraná, Santa Catarina and Rio Grande do Sul). For the State of São Paulo and other regions, no identifiable seasonal annual pattern was evident.[17] The findings of the present study were in line with those from studies of the temperate zone in the Northern hemisphere and suggest that suicide seasonality is linked only to localities situated in the climatic temperate zone, where the four seasons of the year are quite distinct. The States of Paraná, Santa Catarina and Rio Grande do Sul are situated in the temperate zone of the globe, since they are South of the Tropic of Capricorn. The difference observed between the results presented by Benedito-Silva et al.[17] and the present study might be explained by methodological differences. However, the result of a seasonality trend observed in the male sample might reinforce the hypothesis that suicide seasonality depends on the latitude of the studied region, with intermediate results in tropical regions, as was observed by our study in the city of São Paulo.

A recent study[18] that evaluated suicide seasonality using the same database, only over a shorter period (1996 to 2004), used Poisson regression as a method of seasonality analysis. This method has methodological limitations that might compromise the validity of the obtained results, since this regression is applicable only if there is the initial assumption of seasonality in the studied sample. This study also evaluated the association between sunshine exposure and suicide for both genders. Seasonal patterns of suicide were not found, nor any association with sunshine exposure.[18] Another limitation of this study was the definitions used to determine each season. This study considered the Summer months as December, January and February; Autumn as March, April and May; Winter as June, July and August, and finally Spring as September, October and November. This method of month grouping would compromise the seasonal analysis, because the technical period limits of the seasons were the end of December, March, June and September, close to the 22nd, during the respective solstices and equinoxes of each month.[19]

The present study did not evaluate the influence of specific dates like Christmas and New Year, which can have a significant impact on suicide rates, creating a bias in the results of the present work. It is known that on key dates, an "anniversary reaction" may occur in which the individual relives past situations, which can in turn unleash several symptoms such as depression and suicide.[20] Another limitation of our study was the evaluation of a possible suicide seasonality reduction in forthcoming years, as was observed in the study by Ajdacic-Gross et al.[21] Considering this last hypothesis, the observation of the seasonal trend in the male sample reducing with time would explain the observation of Nejar et al.,[18] who evaluated the same population, albeit over a shorter and more recent period.

There is a limitation related to the multiple comparisons analysis, which can reduce the accuracy in the evaluation of the statistical significance of the observed results. The method of mortality registration data follows the worldwide standard, with the same type of restrictions, which allows the comparison with other similar studies. Among the mortality due to external causes, it is known that the suicide is considered as an incident susceptible to underestimation, due to cultural factors and familiar resistance about the act.[22] In line with this trend, other types of deaths for external causes such as murder and traffic accident can cover suicidal acts, which would reduce the real suicide rates. However, the strength of the present study included the good quality ascertainment of death in São Paulo by further epidemiological surveillance.[18]

Conclusion

The suicide rates in the city of São Paulo do not show the typical seasonal annual patterns of cities located in temperate zones. Only six-month period seasonality was found for the male sample. The tropical climate represents a relevant factor in this result because of less clearly delimited transitions among seasons, in other words, thermal and solar radiation amplitude are more tenuous during the year. Other factors could be connected with this result, such as the high degree of urbanization of the city, or social and economic factors.

Disclosures

Writting group member	Employment	Research grant[1]	Other research grant or medical continuous education[2]	Speaker's honoraria	Ownership interest	Consultant/ Advisory board	Other[3]
Daniel Hideki Bando	HU-FMUSP	-	-	-	-	-	-
Hommenig Scrivani	-	-	-	-	-	-	-
Pedro Alberto Morettin	IME-USP	-	-	-	-	-	-
Chei Tung Teng	IPq-HC-FMUSP	-	-	-	-	-	-

* 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.
Note: HU-FMUSP = Hospital Universitário da Faculdade de Medicina da Universidade de São Paulo; IME-USP = Instituto de Matemática e Estatística da Universidade de São Paulo; IPq-HC-FMUSP = Instituto de Psiquiatria do Hospital das Clínicas da Universidade de São Paulo.
For more information, see Instructions for authors.

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