Effects Of Environmental Factors And Atmospheric Pollution In The Incidence Of Hospital Admissions By Stroke In São Paulo City

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Research note

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Abstract

Objectives: To analyze the association between ambient temperature, air humidity and atmospheric pollution with the incidence of hospital admissions for stroke in the city of São Paulo in 2016.

Results: An average in the year 2016 was observed for CO of 0.58 ppm (SD = 0.12), not exceeding 0.81 ppm. For MP10, there was an annual average of 28, 26 µg / m3 (SD = 7.13), ranging from 20, 45 µg / m3 to 42.81 µg / m3. MP2.5 had a mean of 2016 of 13.40 µg / m3 (SD = 5.01). SO2 had an annual average of 1,90 µg / m3 (SD = 0,90), with a minimum of 1,20 µg / m3 and a maximum of 4,20 µg / m3. It is observed that the higher incidence values of stroke were stated in the colder and drier months at the year between May and August, that is evident looking for the female incidence of 769 in August and the male incidence of 8.92 in July. This fact matches with high concentrations of the pollutants, mostly SO2 that had the most relevant value of 4.2 µg / m3 in July.

Introduction

Stroke is one of the major causes of worldwide deaths, difficult to treat and recover from patients [1]. In more severe cases this illness can lead to physical and mental disabilities, which harms the lifestyle of many individuals [2].

Besides, stroke damage may continue even during treatment, because of the encephalic white matter degeneration [3]. This creates an obstacle for rehabilitation, which can be an important factor for people in financial difficulties, on account of its high costs or even labor problems [4].

In this context, the study of some environmental factors, which leads to an increase of stroke incidence, is important because the treatment and prevention of this morbidity are more effective in a risk control scenario [5]. Moreover, the treatment methods of stroke are precarious in many Brazilian areas, fluctuating a lot even in the same town [6].

Environmental factors have great impact on population heath, being that air pollution was associated with at least 5.708.000 deaths all over the world in 2015 [7]. These characteristics surround all the individuals and affects the type of work produced by each person daily, so the quality of life is closely related to the ambient[8].

The atmospheric pollution, temperature and air humidity, already have been associated with stroke risk [9-11]. This can corroborate the increase in cases of stroke in those regions[12]. Therefore, despite the fact that stroke incidence has been falling in Brazilian Southeast in the period from 2008 to 2012 [13], the numbers of death by this disease is increasing due to population rises and epidemiology transition in the country [14].

The residing population in São Paulo, a global metropole is influenced by air pollution and climate changes, due to the accumulation of pollutants in this place by vehicular traffic and industrial gases emitted in the region [15]

Stroke, as already seen, has high rates of mortality and high incidence worldwide [16], as in Brazil. The relationship of this disease with pollution and temperature has already been considered in other studies [17,19]. However, in 2016, the city of São Paulo experienced high pollutant rates in addition to very high or very cold temperatures for national standards. This has raised doubts about how these environmental variables can affect the incidence of hospital admissions for stroke in a large global metropolis.

Thus, the main objective of this article is to analyze the association between ambient temperature, air humidity and atmospheric pollution with the incidence of Stroke in the city of São Paulo, Brazil, in 2016.

Methods

DESIGN OF STUDY AND POPULATION

This is an observational, Ecological study that uses secondary data referring to hospital admissions for Stroke and environmental conditions of São Paulo city, Brazil, in 2016.

The study was conducted with individuals living in the capital of São Paulo, the city with the largest population accumulation in the country, according to the Census of Brazilian Institute of Geography and Statistics [18] .

STUDY VARIABLES

The variables of interest that were studied were:

1. the incidence of hospital admissions for stroke in São Paulo
2. the monthly mean temperature, humidity and air pollutants (particulate matter and pollutant gases) in the city of São Paulo.

DATA COLLECT

The definition of stroke is in accordance with the tenth revision of the International Classification of Diseases (ICD10) codes: I60, I61, I63, and I64, which correspond to intracranial hemorrhage, cerebral infarction, stroke not specified as hemorrhagic or ischemic in the morbidity list of ICD-10. The number of hospital admissions in the city of São Paulo was obtained by the Hospital Information System of the Unified Health System (SIH / SUS), which are available in DATASUS. This database is the official health information of the Brazilian Ministry of Health, and is available for free access to the user at http://datasus.saude.gov.br/.

CETESB is the agency of the state of São Paulo responsible for the control and monitoring of environmental conditions in the region. Data of this company were used to analyze the temperature of the environment, the humidity of the air and the concentration of particulate material and pollutant gases in the place and period studied is this data available in the site http://www.cetesb.sp.gov.br/.

STATISTICAL ANALYSIS

For the descriptive analysis of the quantitative variables, as they had a normal distribution (Shapiro-Wilk test, $p > 0.05$), mean, standard deviation, minimum and maximum were used.

To analyze the association between exposure to pollutants and the incidence of hospital admissions for stroke, the Pearson and Spearman correlation test will be used. The confidence level adopted will be 95% and the statistical program used will be the Data Analysis and Statistical Software for Professionals (Stata) version 13.0®.

ETHICS COMMITTEE

As this study is based on secondary data, since it is not able to identify the individual and the data is free and unrestricted on the Internet, there is no need for this project to be sent to the Research Ethics Committee for its appreciation, as expressed in the resolution 466/2012.

Results

An average in the year 2016 was observed for CO of 0.58 ppm (SD = 0.12), not exceeding 0.81 ppm. For MP10, there was an annual average of 28, 26 µg / m3 (SD = 7.13), ranging from 20, 45 µg / m3 to 42.81 µg / m3. MP2.5 had a mean of 2016 of 13.40 µg / m3 (SD = 5.01). SO2 had an annual average of 1,90 µg / m3 (SD = 0,90), with a minimum of 1,20 µg / m3 and a maximum of 4,20 µg / m3. The mean of the year 2016 for the ambient temperature was 16, 18 ° C (SD = 3.95). Relative humidity had a mean of 55.62% (SD = 7.83). The minimum humidity was 40% and the maximum humidity was 65.17%. The incidence of hospital admissions in females averaged 6.38 (SD = 1.22), ranging from 3.03 to 7.69 admissions. Among men, this mean was 7.61 (SD = 1.47), with a minimum of 3.48 and a maximum of 8.92 hospitalizations (Table 1).

Table 1

Characterization of the sample.

Varibles	**Average (SD)**	**Minimum -maximum**
Carbon monoxide (CO)	0,58 (0,12)	0,44 – 0,81
Particulate Material (MP10)	28,26 (7,13)	20,45 – 42,81
Fine Particulate Material (MP2.5)	13,40 (5,01)	9,25–25,00
Sulfur Dioxide (SO2)	1,90 (0,90)	1,20 – 4,20
Temperature	16,18 (3,95)	9,42 – 22,88
Humidity	55,62 (7,83)	40,00–65,17
Incidence of total female hospital admissions	6,38 (1,22)	3,03–7,69
Incidence of total male hospital admissions	7,61 (1,47)	3,48 – 8,92

SD: Standard Deviation.
Source: Companhia Ambiental do Estado de São Paulo - CETESB (http://cetesb.sp.gov.br). Sistema de Informação Hospitalar (SIH / SUS). Dados disponibilizados pelo Departamento de Informática do Sistema Nacional de Saúde (DATASUS-www.datasus.gov.br). Ministério da Saúde, Brasil.

Table 2

Correlation between pollutant gases, particulate matter, air temperature and humidity with total hospital admissions.

Variables	Total female hospital admissions		Total male hospital admissions	
	rho	p*	rho	p*
Carbon monoxide (CO)	0,220	0,480	0,090	0,780
Particulate Material (MP10)	0,520	0,080	0,270	0,390
Fine Particulate Material (MP2,5)	0,510	0,090	0,240	0,440
Sulfur Dioxide (SO2)	0,800	0,002	0,570	0,005
Temperature	-0,450	0,140	-0,190	0,560
Humidity	-0,160	0,620	0,060	0,860

* Spearman's correlation test .
Source: Companhia Ambiental do Estado de São Paulo - CETESB (http://cetesb.sp.gov.br). Sistema de Informação Hospitalar (SIH / SUS). Dados disponibilizados pelo Departamento de Informática do Sistema Nacional de Saúde (DATASUS-www.datasus.gov.br). Ministério da Saúde, Brasil.

A positive correlation between the pollutants and the incidence of hospital admissions for total stroke in women, CO (rho: 0.22, p = 0.480), MP10 (rho: 0.52, p = 0.080), SO2 (rho: 0.80, p = 0.002), and MP 2.5 (rho: 0.51, p = 0.090). For the male, a positive correlation was also observed between these variables, CO (rho = 0.09, p = 0.780), MP10 (rho: 0.27, p = 0.390), SO2 (rho: 0.570, p = 0.005) and MP 2.5 (rho: 0.24, p = 0.440). In this study, it is observed that the higher incidence values of stroke were stated in the colder and drier months at the year between May and August, that is evident looking for the female incidence of 769 in August and the male incidence of 8.92 in July. This fact matches with high concentrations of the pollutants, mostly SO2 that had the most relevant value of 4.2 µg / m3 in July (Fig. 1).
There was a negative correlation between temperature and the incidence of total stroke in women and men. In the case of relative air humidity, there was a positive correlation with the incidence of total stroke for men, however, this correlation is negative for women. It is also observed that only correlations involving SO2 were statistically significant (Table 2).

Discussion

The current study was carried out in the city of São Paulo, a large, heavily industrialized state region. In this study, the main findings were the higher rate of hospital admissions for stroke in males compared to females, in addition to the positive correlation found between the concentration of SO2 and the incidence of stroke.

One study analyzed mortality from stroke in the large Brazilian metropolises, including São Paulo, and found that mortality in men due to this morbidity is higher when compared to women [20]. This may be related to the higher incidence of male hospital admissions found in the present study, as the samples in both cases are similar.

In addition, the higher rate of hospital admissions in men compared to women has already been described in a review proposed by Piassaroli et al, who used a total of 92 articles on the subject related to stroke [21], and most of these articles proves a similar scenario, with a higher incidence in men. Furthermore, in an ecological study similar to this, Alcantara et al, found that the incidence of stroke in men is 19% higher than in women [22]. Thus, the present study follows the same proportion, with the incidence in men being 7.61 and in women being 6.38, which shows that our results corroborate a tendency regarding sex.

The positive correlation between the SO2 concentration and the incidence of hospital admissions for stroke in both sexes may be justified by the absorption of this gas in the membranes of the respiratory tract, which may contribute to the activation of neuronal signals that stimulate bronchial constriction and cardiovascular, as already explained by Tunnicliffe, in a study on the effects of SO2 in adults, where he found that this gas participates in neural mechanisms [23].

In this scenario, it is possible to notice that the increase of SO2, generates an increase in hospital admissions for stroke in São Paulo, which are more present in the colder months of the year, periods in which the SO2 rates reach the highest averages. This increase in SO2 in these months can be understood

as a consequence of the thermal inversion, which occurs in the coldest time of the year, reducing the dispersion of pollutants [17].

Other pollutants studied were positively correlated with the incidence of stroke. However, no other pollutant in question had a statistically significant result ($p > 0.05$). Huang et al. stated in their study that it is not possible to accurately correlate stroke with particulate matter, which corroborates our result, since this correlation can vary even in the same year in different seasons [1]. In the case of carbon monoxide, the statistically insignificant result may be influenced by a protective role that this gas promotes in low concentrations against ischemic stroke, as already explained by Wang et al. [24] in his study on the effects of CO as a neuro protector.

Conclusion

Stroke is, indeed, a morbidity that affects many individuals in the city of São Paulo. This impairs public finances, the difficult treatment, which involves long periods of rehabilitation, or even the dependence on the care of the patients of stroke for the rest of their lives, being an important negative factor for the quality of life of the population, which has accessible information to prevent this disease.

In the present study, it was observed that there is a positive correlation between total hospital admissions for stroke and the concentration of atmospheric pollutant Sulfur Dioxide (SO2). This fact must be considered in the preparation of public measures for the intervention in the dispersion of pollutants, so concentrated in the city of São Paulo.

Limitations

The faint association of other pollutants, but SO2, can be considered a negative point of this study. This can be explained by analyzing each pollutant separately and in a short period, which can camouflage possible reactions between the organism and all pollutants together. In a review, for example, by Ljungman et al. [25], it was possible to point out that such correlation has already been studied in developed countries. In addition, Lipsett et al [26] stated that long-term exposure to particulate matter and fine particulate material significantly increases the risk of stroke.

Abbreviations

1. ICD10: International Classification of Diseases
2. SIH / SUS: Hospital Information System of the Unified Health System
3. SD: Standard Deviation
4. CO: Carbon Monoxide
5. SO2: Sulfur Dioxide
6. MP10: Particulate matter

7. 5: Fine Particulate matter

Declarations

Ethics approval and consent to participate

How this is a study that uses secondary data, it is not possible to identify the subjects of the research and because it has free and unrestricted access on the Internet, it is exempt from the evaluation of the research ethics committee according to resolution 466/2012 of the national health council.

Consent to publish

That the manuscript has been approved by all authors, who agree to cede the copyrights to the Journal

Availability of Data and Materials

All data can be accessed by the official databases section of Brazilian Ministry of Health at the following link:

http://datasus.saude.gov.br/.

And

http://www.cetesb.sp.gov.br/.

Competing Financial Interests statement

The authors declare no conflict of interest related to the publication of this article.

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Authors' contributions

AART participated in the design of the study, statistical analysis and writing. LVAS, LSP, FA and FLAF participated in the statistical analysis and revising the manuscript. All authors read and approved the final version of the manuscript.

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Figures

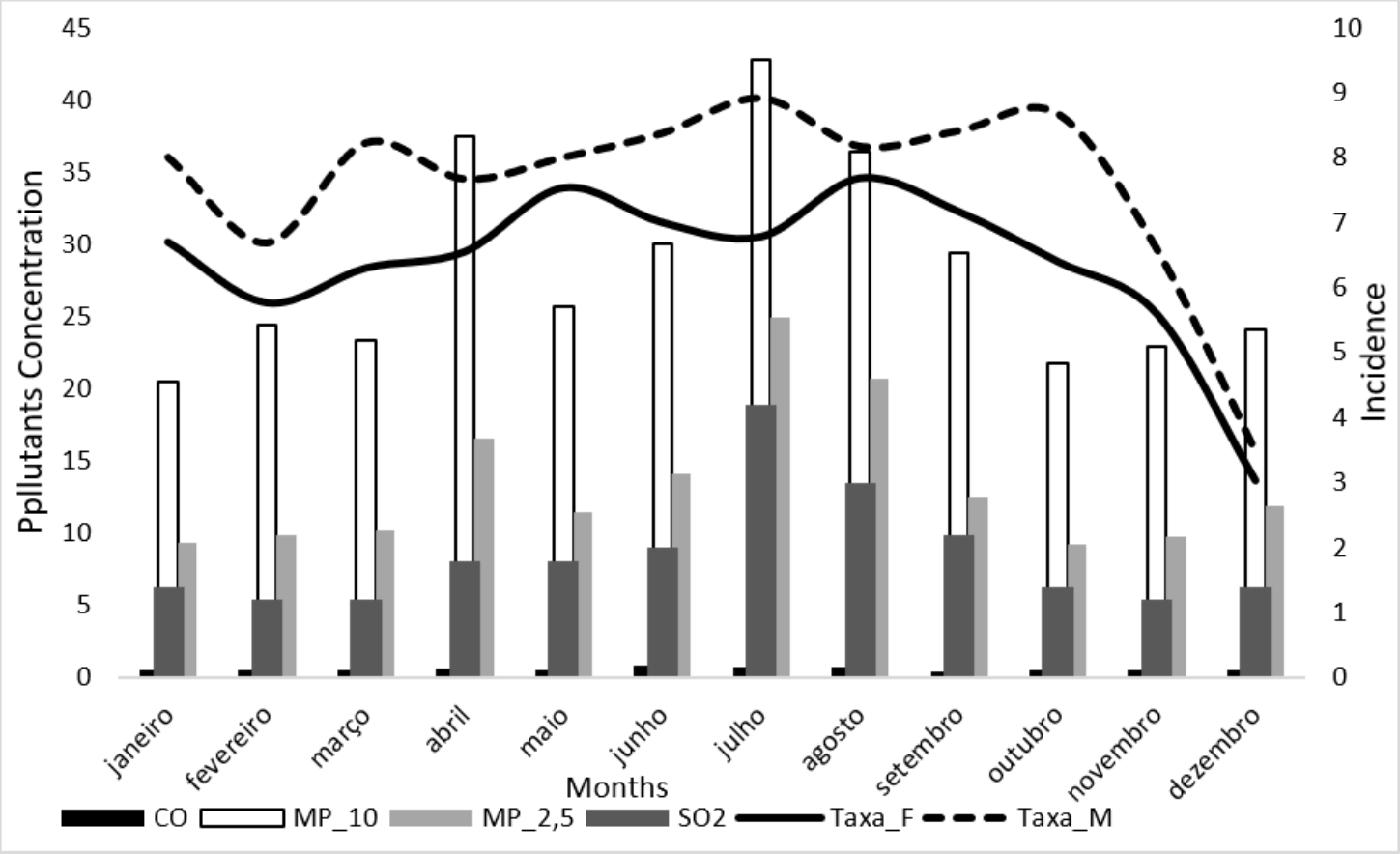

Figure 1

Graphic illustration of the atmospheric pollution variation by month and its correlation with the incidence of Stroke between a year.