Increase in mean temperature affects mortality by stroke in a Tropical environment

Priscilla Venâncio Ikefuti pvikefuti@usp.br Ligia Vizeu Barrozo lija@usp.br Alfésio Luís Ferreira Braga alfesio@gmail.com

Faculdade de Filosofia Letras e Ciências Humanas

FAPESP

ABSTRACT

Among the main components that define human health, some from the geographic context as local climate, Some components of the geographic context (e.g., local climate) seem to influence mortality from circulatory disease as stroke. This influence is not consensus yet in the literature, setting up a discussion with important gaps to be filled. Thus, the main objective of this project is to investigate the influence of geographic context (meteorological variables) in mortality by circulatory diseases (stroke) in São Paulo in the period from 2002 to 2011. **Key words:** Climate and health, stroke, meteorological variables and São Paulo

BACKGROUND

In 2008 more than 9 million people died prematurely from cardiovascular disease (CVD). About 8 million of these deaths occurred in peripheral countries (World Atlas of Cardiovascular Diseases, 2011).

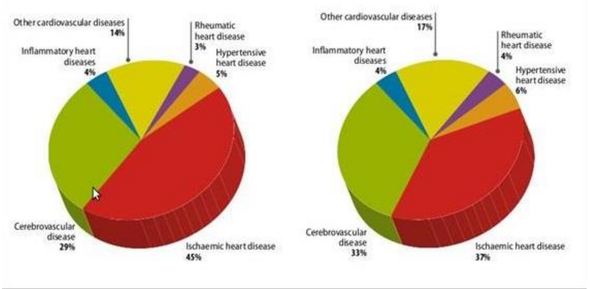

Figure 1: Percentage of cardiovascular disease in men and women.
Source: World Atlas of Cardiovascular Diseases (2011).

In São Paulo, with a population of more than 11 million people in 2013, located at the latitude 23º32'52" S, where normal mean, minimum and maximum temperatures are 19,4º, 15,2º, 25,4ºC, these relationships were not investigated so far. Thus, the aim of this study was to investigate the influence of temperature on stroke mortality in São Paulo.

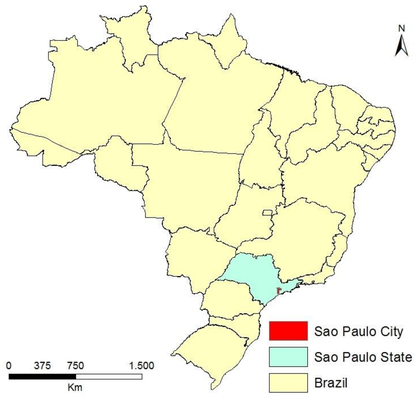

Figure 2: Location of São Paulo city.

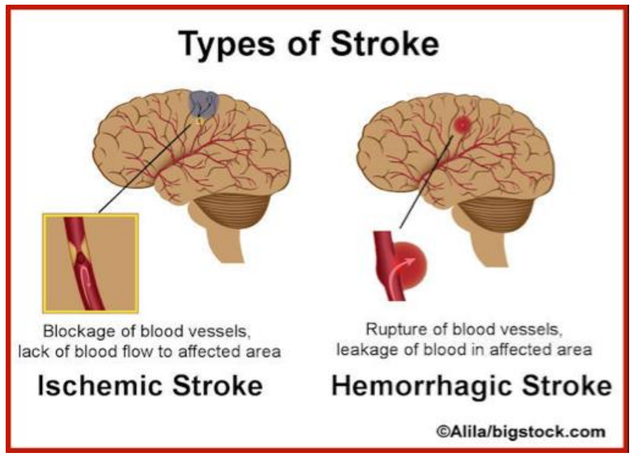

Figure 3: Types of stroke (Ischemic and Hemorrhagic).

METHODS

Daily mortality for stroke, meteorological variables and air pollution data were obtained for the period of January 2002 to December 2011. The percentage increase of mortality for total stroke, hemorrhagic, and ischemic stroke were estimated with endpoint-specific generalized additive Poisson regression models. Nonparametric smooth function was used to control seasonality and an indicator of holidays was adopted to control short-time trend. Effects of mean temperature, humidity, thermal amplitude, barometric pressure and air pollutants were assessed using specific third-degree polynomial distributed lag models for a time window of eight days. The models were controlled for humidity, atmospheric pressure, thermal amplitude and pollutants. The use of Generalized Additive Models (GAM) is an alternative that allows, in a simple way, the control of these confounding factors, since this type of model eliminates the need to specify a parametric form for the association between predictors and response. The R (R Development Core Team 2014) software was used for all analyses.

RESULTS

In descriptive statistics table it is observed that minimum daily deaths from stroke was 2 and the maximum 32 for the period 2002 to 2011 For ischemic and hemorrhagic subtypes the maximum was 12 and 15 deaths respectively.

The percentage increase calculated for outcomes were more significant in the early days of temperature exposure, indicating a rapid influence of this variable on mortality.

For all stroke cases the percentage increase is 6.2% for each 1 ° C increase in average temperature, for the female gender is 5.7%, and 4.8% for males (Table 3). For most ages 65 the percentage increase is 1.3, 7.8 and 1.1% for women and men respectively. As for the age group 35 to 64 years only the data obtained with both genres significance, a percentage increase of 4.8% in mortality.

Table 1: Descriptive statistics of the studied outcomes: stroke, hemorrhagic stroke and ischemic stroke.

	Average	Standard Error	Standard Deviation	Variance	Minimum	Maximum	Sum
Stroke	15.24	0.07	4.16	17.30	2	32	55663
Stroke female	7.99	0.05	2.90	8.41	0	19	29197
Stroke male	7.25	0.05	2.79	7.77	0	19	26465
Stroke > 65	10.41	0.06	3.41	11.63	1	23	38017
Stroke > 65 female	5.81	0.04	2.46	6.06	0	16	21219
Stroke > 65 male	4.60	0.04	2.22	4.94	0	13	16798
Stroke 35-64 years	4.54	0.04	2.18	4.77	0	17	16587
Stroke 35-64 years female	2.05	0.02	1.45	2.11	0	9	7474
Stroke 35-64 years male	2.50	0.03	1.60	2.57	0	12	9113
*HS**	4.72	0.04	2.24	5.01	0	15	17250
HS female	2.49	0.03	1.58	2.49	0	12	9085
HS male	2.24	0.03	1.52	2.30	0	10	8165
HS > 65	1.99	0.02	1.43	2.03	0	10	7275
HS > 65 female	1.13	0.02	1.06	1.13	0	6	4137
HS > 65 male	0.86	0.02	0.94	0.89	0	6	3138
HS 35-64 years	2.51	0.03	1.60	2.56	0	10	9165
HS 35-64 years female	1.25	0.02	1.12	1.26	0	9	4566
HS 35-64 years male	1.26	0.02	1.12	1.26	0	6	4599
*IS***	3.34	0.03	1.93	3.74	0	12	12183
IS female	1.75	0.02	1.37	1.88	0	8	6379
IS male	1.59	0.02	1.30	1.69	0	8	5804
IS > 65	2.55	0.03	1.69	2.85	0	11	9307
IS > 65 female	1.43	0.02	1.23	1.50	0	7	5236
IS > 65 male	1.11	0.02	1.08	1.17	0	8	4071
IS 35-64 years	0.76	0.01	0.88	0.78	0	5	2766
IS 35-64 years female	0.30	0.01	0.55	0.30	0	5	1082
IS 35-64 years male	0.46	0.01	0.69	0.48	0	4	1684
** Hemorrhagic Stoke*							
***Ischemic Stroke*							

Table 2: Percentage Increase in stroke mortality for an increase of 1 °C in the average temperature.

Outcome by group	Percentage increase	CI
Stroke	6.2	3.3 - 9.0
Stroke female	5.7	2 - 9.6
Stroke male	4.8	1.6 - 8.2
Stroke > 65 years	1.3	0.6 - 2
Stroke > 65 years female	7.8	3.1 - 12.7
Stroke > 65 years male	1.1	0.1 - 2.2
Stroke 35-64 years	4.8	1 - 8.5
Stroke 35-64 years female	NS	NS
Stroke 35-64 years male	NS	NS

NS: Not Significant.

The HS showed no significant values with percentage increases with the daily average temperature. Contrary Morabito et al. (2011) study in the city of Tuscany in Italy found significant results between the mean temperature and the incidence of HS in largest 65 people.

The calculated relative risk for ischemic stroke was very significant for the increase of 1 ° C, 12% on the first day of exposure, and for the female gender 5% on the second day after exposure of the average temperature. For the male gender no significant results were found.

For most age 65 the risk increases to 14.1% in the total ischemic stroke and keeps similar to the female gender (4.7%), between 35 to 64 years, the risk was 5.6% with the increase in temperature of 1 ° C average.

Table 3: Percentage Increase in stroke mortality for an increase of 1 °C in the average temperature.

Outcome by group	Percentage Increase	CI
IS	12	4.7 - 19.5
IS female	5*	1.2 - 8.8
IS male	NS	NS
IS > 65 years	14.1	8.1 - 20.4
IS > 65 years female	4.7*	0.6 - 8.9
IS > 65 years male	NS	NS
IS 35-64 years	5.6	0.3 - 10.9
IS 35-64 years female	NS	NS
IS 35-64 years male	NS	NS

NS: Not Significant
*effect with a lag of one day

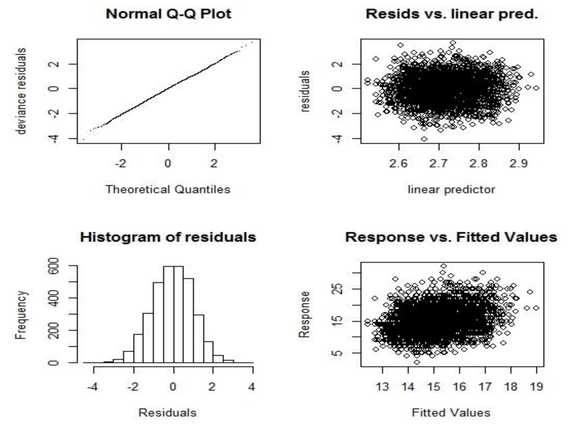

Figure 4: Diagnosis graphic from GAM.

CONCLUSION

The increase of mean temperature affects total stroke mortality and, in especial, the ischemic subgroup in this city in a Tropical area. This reinforces the concept that the subgroups of stroke, ischemic and hemorrhagic, may present different pathophysiologic mechanisms and, hence, different risk factors.

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