

Incidence of Climate on the Number of Admissions and Deaths Due to Cerebrovascular Diseases Through Mathematical Modeling In Sagua La Grande, Villa Clara, Cuba

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ABSTRACT

The number of deceased cases and admissions for annual cerebrovascular diseases were modeled in Sagua la Grande, Villa Clara province, Cuba, between 1993 and 2017. A statistical description of these two variables was made, with an average admission of 148.7 cases, with a standard deviation of 24.9. The deceased had an average of 35.7 with a standard deviation of 13.2, the results were obtained using the Regressive Objective Regression (ROR) methodology. The impact of the minimum temperature and atmospheric pressure of the Sagua La Grande station was studied, reaching the conclusion that as the minimum temperature increases, the income and deaths increase, so this impact is related to the climate change, when the minimum temperature increases by 1 °C, deaths increase by 9 cases, while when the maximum temperature increases by 1 °C, deaths increase by 11.6 cases. In the case of revenue, as the atmospheric pressure increases by 2 hPa, the amount of revenue decreases by 1 case.

KEY WORDS: CUBA; CVD; DEATHS; CLIMATE IMPACT; INCOME; MODELING; ROR REGRESSION.

INTRODUCTION

Cerebrovascular disease is a hierarchically broad term, I a syndrome that includes a group of heterogeneous diseases with a common point: an alteration in the vasculature of the central nervous system, leading to an imbalance between oxygen supply and oxygen requirements, the consequence of which is a focal dysfunction of brain tissue (Garcia et al., 2019).

The frequency of cerebrovascular disease increases with age and predominates in patients of male sex and black

complexion. According to data from 11 studies conducted in Europe, Russia, Australia and the United States, the worldwide incidence of CVD was estimated at 300 to 500 x 105 inhabitants per year, between 45 and 84 years of age. Every 10 years, the incidence increases significantly above 35 years of age and triples to 3000 x 105 inhabitants in individuals over 85 years of age. The incidence of cases/year in the USA is 531 to 730 000, 127 000 in Germany, 112 000 in Italy, 101 000 in the United Kingdom, 89 000 in Spain, 78 000 in France, 60 000 in Poland and 55 000 cases in Japan. In Brazil, a rise in the crude CVD mortality rate has been observed in the last three decades; a trend of shifting to younger ages was detected (Priscilla and Ikefutiligia, 2018; Sera et al., 2018).

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Ischemic stroke is triggered by a series of biochemical processes resulting from the disruption of cerebral blood flow. It involves a complex mixture of different biomolecular events that originate and develop through the ischemic cascade, generating excitotoxicity, which together trigger irreversible cellular injury (Salas, 2020).

Stroke is caused by risk factors that, when affecting a patient, trigger the entity, but the triggering or predisposing factors are those that, when affecting vulnerable patients with several risk factors, are able to start or provoke a disease crisis. One component of the physical environment (environment) that potentially influences diseases of the circulatory system is the local meteorological variables. This influence is direct and indirect and can act positively or negatively (Gonzalez et al., 2019). One of the diseases, which according to multiple research results, is also influenced by weather and climate changes, are cerebrovascular diseases (Alcalá, 2021; Icalá, 2021).

In Spain, variations in atmospheric pressure act as a trigger factor for stroke, and it has been shown that increased atmospheric pressure increases the incidence of hemorrhagic stroke (Jiménez, 2008). With the arrival of cold weather in the southern and southeastern regions of Brazil, it may bring with it an increase in the number of deaths from cerebrovascular accidents (CVAs), mainly among the population over 65 years of age (Ikefutiligia et al., 2018; Icalá, 2021).

In Russia the number of strokes increases with temperature, daily thermal amplitude. Strokes were more sensitive to inclement weather than myocardial infarctions (Shaposhnikov et al., 2014). In Cuba, in 2020 there were 10 821 deaths with a crude rate of 90.4 X 100 000 inhabits. and an adjusted rate of 39.7 X 100 000 inhabits. In Villa Clara in this year, the total number of deaths from this cause was 668 for a crude rate of 85.9 per 100 000 inhabitants (MINSAP, 2021).

Various studies estimate that a large part of the population is vulnerable to sudden changes in temperature, humidity and atmospheric pressure. Respiratory and cardiovascular pathologies are usually the most related to atmospheric impacts (Altea, 2016; Sauchay et al., 2017; Priscilla and Ikefutiligia, 2018).

In view of the above, there is a need to investigate the effects of meteorological variables on human health, which are seen with greater incidence due to climate change and have a direct impact on cerebrovascular disease.

The objective of the research was focused on using descriptive statistics of these variables, modeling them and predicting their quantity, so that measures can be taken to reduce their influence, as well as to measure the impact of climate variables, both on deaths and admissions due to this cause.

The Objective Regressive Regression (ORR)

Methodology:

For the forecast of admissions and deaths, we modeled using the methodology of the Regressive Objective Regression ROR (Osés and Grau, 2011), for which we create in a first step, dichotomous variables DS, DI and NoC where:

NoC - Number of base cases,

DS = 1, if NoC is odd; DI = 0, if NoC is even, when DI=1, DS=0 and vice versa.

Subsequently, the module corresponding to the Regression analysis of the statistical package SPSS version 19.0 (IBM Company) was executed, specifically the ENTER method where the predicted variable and the ERROR are obtained.

Then the autocorrelations of the variable ERROR were obtained, paying attention to the maximums of the significant partial autocorrelations PACF. The new variables were then calculated taking into account the significant Lag of the PACF. Finally, these regressed variables were included in the new regression in a process of successive approximations until a white noise in the regression errors was obtained.

The data correspond to the years from 1993 to 2017 belonging to the hospital of Sagua La Grande, Villa Clara, Cuba. The climatic variables correspond to the same period from the meteorological station of Sagua La Grande (Latitude: 22°13' N, Longitude: 80°02' W).

Meteorological variables act as precipitating factors of CVD, both ischemic and hemorrhagic, where the slowing of circulation, increased viscosity, redistribution of blood flow, and increased sympathetic action are the main impacts on the cerebral circulatory system. As the temperature rises, the number of admissions increases; rising temperatures, both maximum and minimum, increase the number of fatalities. Temperature and its variations cannot be catalogued as risk factors, but as triggering factors, capable of causing a stroke in patients with risk factors and low adaptive capacity. Elderly patients are therefore the most vulnerable group.

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