The virtual conference of AQUA≈360: Water for All - Emerging Issues and Innovations

31st August 2021 – 2nd September 2021, University of Exeter, United Kingdom

Zika virus in Brazil: a preliminary study about the influence of meteorological variables on the number of cases using statistical modelling.

I. V. G. Borges[1], A. Musah[2], L. Dutra[1], A. Aldosery[2], C. L. de Lima[3], G. M. M. Moreno[3] , M. Tunali[4], S. Basibuyuk[4], O. Yenigün[4], T. Massoni[5], W. P. dos Santos[3], P. Kostkova[2], T. Ambrizzi[1], L. C. Campos[6]

[1] Department of Atmospheric Sciences, IAG, University of São Paulo, São Paulo, Brazil
[2] Centre for Digital Public Health and Emergencies, Institute for Risk and Disaster Reduction, University College London, London, United Kingdom
[3] Department of Biomedical Engineering, Federal University of Pernambuco, Recife, Brazil
[4] Boğaziçi University, Institute of Environmental Sciences, Istanbul, Turkey
[5] Department Systems & Computing, Federal University of Campina Grande, Campina Grande, Brazil
[6] Department of Civil Environmental & Geomatic Engineering, University College London, London, United Kingdom

[1] *iurivalerio@usp.br*

Keywords: Zika virus, modelling, weather conditions, regression, surveillance

EXTENDED ABSTRACT

Introduction

The problem of arboviruses such as dengue, yellow fever, chikungunya and zika has become a growing issue in the Americas in recent years, with *Aedes Aegypti* being one of the main vectors of this type of disease [1]. Even after several efforts by public authorities to eradicate this vector in the fight against yellow fever in the 50s and 60s, there was a re-infestation in the early 80s and 90s in large urban centers [2]. In 2016, the World Health Organization (WHO) declared a state of emergency of public health of international interest after the arrival of the Zika virus in the Americas was confirmed, with data on its arrival in Brazil in 2015, with 2016 being an epidemic year of the disease in the country. Several studies have been carried out to try to understand the dynamics and possible enhancers of the transmission of the *Ae. Aegypti* mosquito, being observed, for example, the influence of meteorological variables on the growth of the vector's larval population [3]. Precipitation seems to be the most correlated, largely because it provides the supply of clean water in the breeding sites, which is a fundamental element of the vector's life cycle. Understanding how these and other parameters interfere with the mosquito populations makes it possible to predict population growth and alerting public administrations to take appropriate mitigation measures. The present work uses a Poisson-based multivariable Negative Binomial regression model that explores the relationship between 4 meteorological variables and the number of confirmed cases of zika virus in the two Brazilian cities namely Rio de Janeiro and Recife.

Methods and Materials

The study period of the present work refers from the year of 2017 to 2019. Although data on confirmed cases of zika virus are available in Brazil from 2016, this year was removed from the study since it presents itself as an atypical period of the rest of the time series for being a major epidemiological outbreak in the country, which makes it unfeasible to consider if we seek to relate it to the seasonal patterns of the meteorological variables. For the analysis in the model, data were obtained from meteorological stations of the National Institute of Meteorology (INMET) in the cities of Rio de Janeiro (Vila Militar station) and Recife (Curado station) regarding precipitation, temperature, days of precipitation and atmospheric pressure. Missing measurements was interpolated with the average of the entire column of the data. The number of confirmed cases of zika virus in both cities was obtained through the public platform provided by the Brazilian Health System, Data-SUS. All data are presented in the monthly temporal frequency. The multivariate regression model used in the research is the Negative Binominal type, the model formulation for a negative binomial multivariable regression is given below.

$$y_i^{(r)} = \exp\left(\beta_0^{(r)} + \sum_p x_{p,i}^{(r)} \beta_{p,i}^{(r)}\right) \quad \text{(Equation 1)}$$

The model parameter y_i is the number of Zika cases recorded in the month *i* and in city *r* (i.e., Rio de Janeiro and Recife). The intercept is β_0 and $x_p$represents the four meteorological variables where p = 1, 2, 3 and 4; and β_p represents the levels of association between each meteorological variable and Zika cases measured monthly. By exponentiating the β_p we obtain an incidence risk ratio (IRR) which is reported alongside its 95% confidence intervals (95% CI). Statistical significance of an IRR was deemed if a p-value < 0.05. It should be noted that an IRR greater than 1 indicates an increased risk of Zika in relation to the one of these independent meteorological variables, whereas an IRR below indicates a reduction in the risk of Zika in relation to these covariates.

Results and Discussion

Tables 1 and 2 show the most important meteorological variables presented in their respective cities, followed by the calculated values of incidence risk ratios (IRR), p-value and 95% CI [4].

Table 1. Negative Binominal Regression for Zika cases in Rio de Janeiro

Variable	IRR	p-value	95% CI
Temperature	1.448	0.005	1.117 to 1.878
Pressure	1.274	0.024	1.032 to 1.571

Table 2. Negative Binominal Regression for Zika cases in Recife

Variable	IRR	p-value	95% CI
Temperature	0.156	0.051	0.024 to 1.005

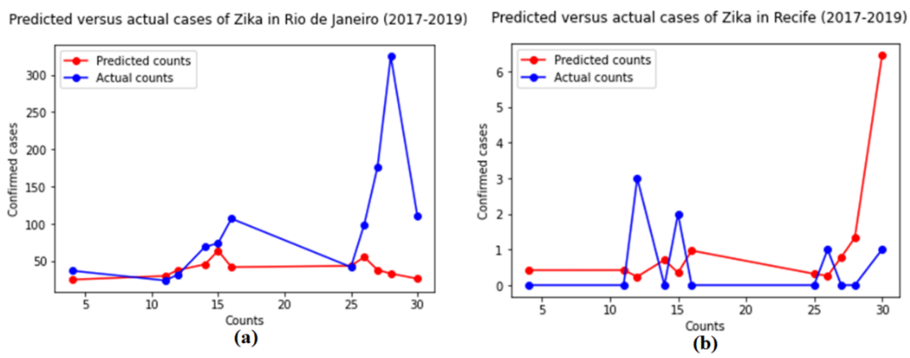

Figure 1. Performance comparison of the negative binominal model for (a) Rio de Janeiro (b) Recife.

Conclusions

Given the data presented, it is possible to affirm in this initial phase of the study that, for both cities, temperature was the most important variable for the model when trying to describe the burden of Zika cases during the epidemic, followed by atmospheric pressure, the latter being significant only for the city of Rio de Janeiro. It is important to highlight that, although significant p-values have been found, the size of the time series is too short for more categorical conclusions to be made, since only 3 years of data are being analyzed on a monthly frequency. This problem might be partially solved by the use of daily frequency data as well as the use of confirmed cases of dengue instead of zika, because, despite not being the same arbovirus, the transmission vector remains the same and, unlike zika, dengue supersedes it in terms of it being more common in Brazil.

REFERENCES

[1] S. Singhi, N. Kissoon, and A. Bansal, 'Dengue and dengue hemorrhagic fever: management issues in an intensive care unit', *J. Pediatr (Rio J)*, vol. 83, no. 2, pp. 22-35, 2007, doi: 10.2223/JPED.1622.

[2] M. G. Teixeira, M. L. Barreto, and Z. Guerra, 'Epidemiology and Preventive Measures of Dengue', *Informe epidemiológico do SUS*. vol. 8, no. 4, pp. 5-33, Oct/Dez 1999. ISSN 0104-1673.

[3] I. C. S. Santos, C. Braga, W. V. Souza, A. L. S. Oliveira, and L. N. Regis, 'The influence of meteorological variables on the oviposition dynamics of *Aedes aegypti* (Dipteria: Culicidae) in four environmentally distinct areas in northeast Brazil', *Mem. Inst. Oswaldo Cruz*, vol. 115, pp. 1-10, Jun. 2020, doi: 10.1590/0074-02760200046

[4] A. Musah, A. Rubio-Solis, G. Birjovanu, W. P. Santos, T. Massoni, and P. Kostkova, 'Assessing the Relationship between various Climatic Risk Factors & Mosquito Abundance in Recife, Brazil', *International Digital Public Health Conference Proceedings*, pp. 97-100, Nov. 2019, doi: 10.1145/3357729.3357744