CASE STUDY 4B

UNDERSTANDING THE SENSITIVITY OF DENGUE TO CLIMATE AND URBAN RISK FACTORS IN MINAS GERAIS STATE, BRAZIL

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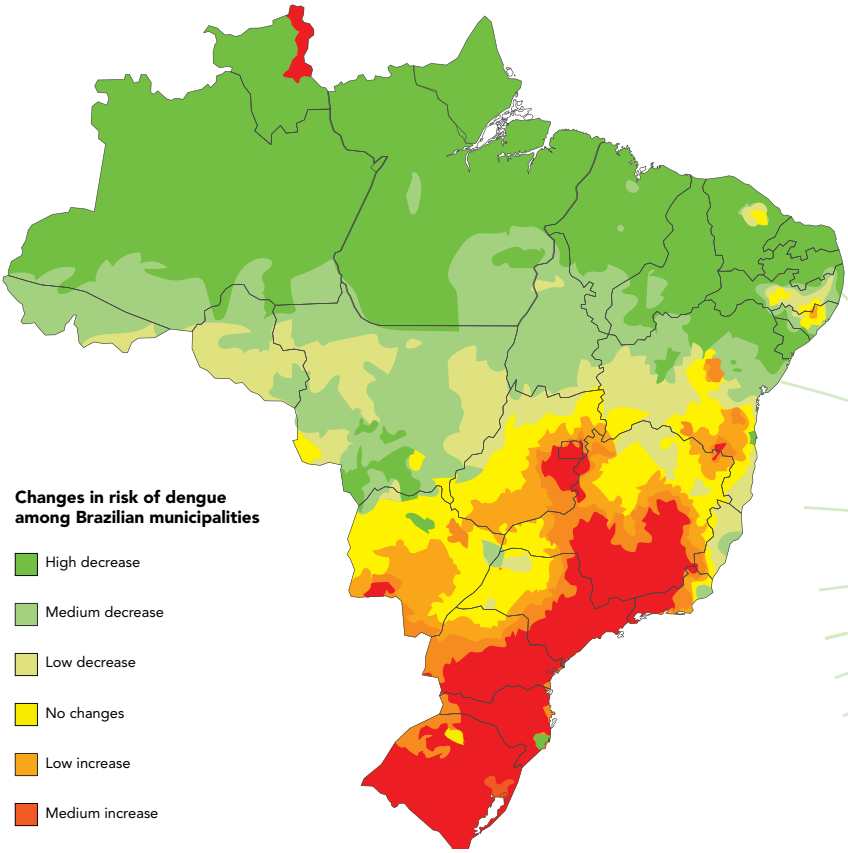
Research

CONTEXT

This study was motivated by the complex dengue epidemic that has continued in the Brazilian state of Minas Gerais since the 1990s, and the related difficulties faced by the public health sector to promote effective vector control activities and reduce transmission of the virus in vulnerable populations *(2,3)*. It is part of an ongoing study of dengue and climate variables by the WHO Centre for Health Development's Observatory for Urban Health at the Kobe Centre in Japan, which is implemented in partnership with local, regional and country-level health authorities.

Figure 4.5 Thematic map, rainfall versus epidemics.



NEW APPROACHES

The aim of the study was to assess dengue vulnerability to climate, geographical and demographic factors in order to support the public health service to address climate change-related risk using a vector-borne disease model. To do so, the occurrence of dengue was investigated in relationship to climate variability in an urban environment.

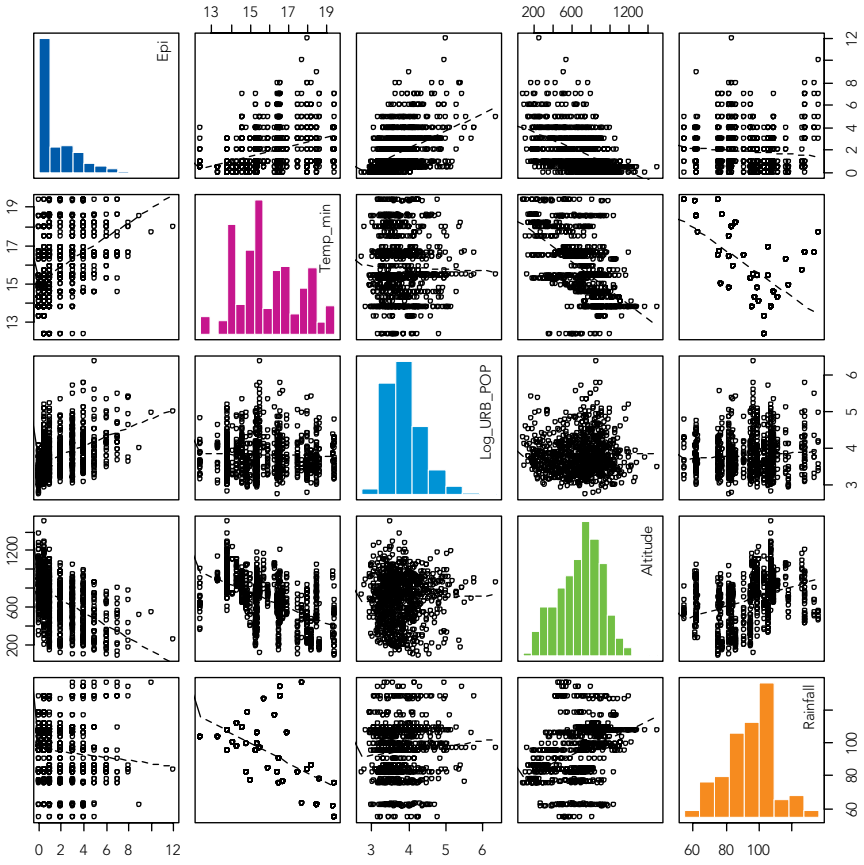
The study first investigated the historical time–space relationship between dengue epidemics and climate, geographic and demographic variables in Minas Gerais State, in the Southeast Region of Brazil, from 2001 to 2014. Based on a proposed theoretical model *(4)*, reported cases of dengue were geocoded by county and macro region. Data on rainfall, altitude and temperature were obtained from the National Meteorological Institute, a government agency managing weather and climate information throughout Brazil. Urban population density data are publicly available from the Brazilian Institute of Geography and Statistics *(5)*.

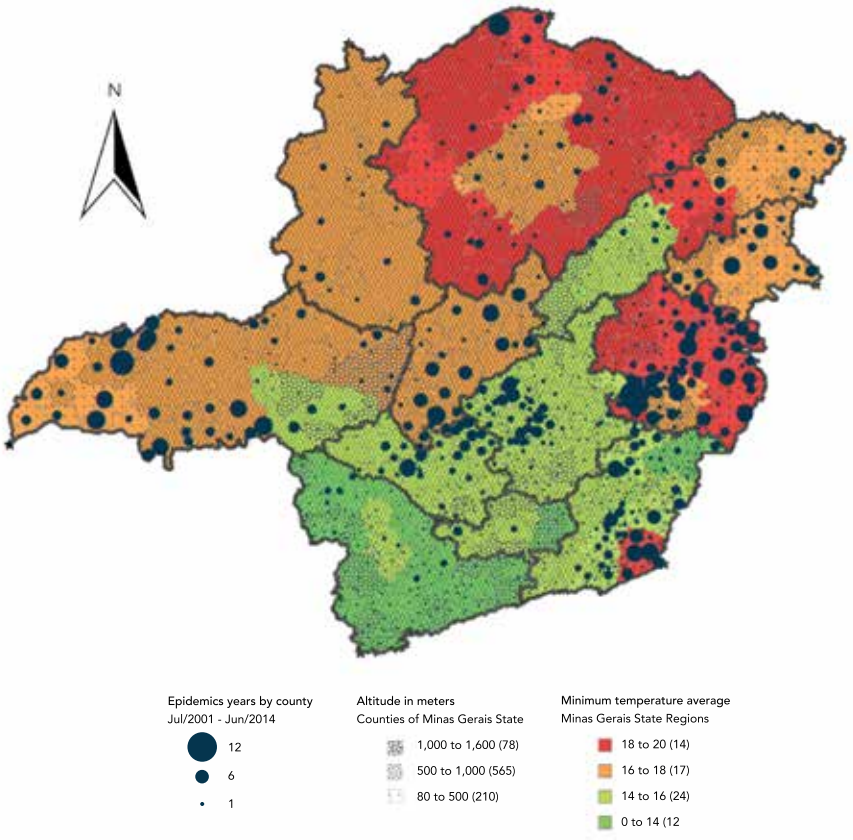
The dengue epidemic occurrence was defined as the cumulative incidence rate greater than 300 cases per 100 000 inhabitants per annual cycle from July to June *(5)* in all 853 state counties, during the 13 years of observation. Independent variables for each municipality were: 1) Weather (comprising rainfall in millimeters and temperature by degrees of Celcius, obtained from the national meteorological service INMET); 2) Geographic (altitude in meters; and 3) Demographic (urban population density by inhabitants within urban areas).

Initial analysis involved graphical inspection of the correlation of all variables ($r=0.71$). Multiple linear regression analyses showed significant associations ($p<0.01$) of average temperatures ($ß=0.35$), rainfall ($ß=0.02$), altitude ($ß=-0.003$) and urban population density ($ß=15.41$).

In the second phase of the study, geographic information systems (GISs) were used to compare climate averages to dengue incidence rates in macro-regions and municipalities *(5)*. The results show an overlapping of high incidence rates of dengue with hot and densely populated regions (Figure 4.4; Figure 4.5).

Figure 4.6 Scatter matrix showing associations between epidemiological data, minimum temperature, urban population, altitude and rainfall (top); Thematic map showing temperature, altitude and number of epidemic years (bottom).





ACKNOWLEDGEMENTS

BENEFITS AND LESSONS

The results of this study have been communicated in scientific forums to public health authorities and other research groups. They have been presented by means of maps and charts for discussion among specialists from various fields. This approach has proven to be effective in enhancing the understanding of the etiology of this climate-sensitive vector-borne disease, and it has created a favourable environment for the debate on how to further investigate dengue in relation to climate and environmental factors *(5)*. For effective participation in such discussions, public officials needed to be instructed in a wide range of disciplines – such as health, geography, demography and statistics – in order to achieve efficient dengue control protocols and actions, and capture the complexity and diversity of factors affecting the transmission of the disease.

Considering the ubiquitous distribution of the dengue vector, its correlation with geographic and climatic factors *(6)*, and the special climatic conditions and changes in urban areas (such as increases in the minimum annual temperature in cities over recent years and the well-documented urban 'heat-island' effect), systematic integrated monitoring is needed to further investigate the combined effects of these variables on dengue, mainly in urban settings with a high, non-uniformly distributed population density. Therefore, initiatives aiming to assess smaller geographical units within a city, comprising intra-urban microclimates (*7)* have high potential to contribute to the mitigation of risk of dengue transmission associated with climate change *(4)*. The lack of intersectoral coordination, and of climate data and tools to perform appropriate analyses, are obstacles to conducting adequate integrated surveillance and monitoring.

Intersectoral approaches can facilitate discussion and the creation and support of a network for exchange of information, experience, scientific production and structuring of health services. Fundraising is an essential prerequisite for multidisciplinary projects aiming at expanding monitoring and enhancing knowledge on dengue vector control and factors influencing dengue transmission.