Prediction of Dengue Incidence Based on Time Series Modelling in the District of Colombo, Sri Lanka

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Timely implementation of intervention activities, is essential in controlling dengue epidemics. This requires the prediction of dengue epidemics, while respecting the spatial and temporal trends in dengue incidence. However, such aspects are limitedly focused in dengue epidemic management of Sri Lanka. Therefore, the current study was conducted to develop a temporal prediction model for dengue incidence in the district of Colombo in Sri Lanka. Dengue cases reported from 2000 to 2018 in the district of Colombo were collected from the Epidemiology Unit, Sri Lanka. Selected meteorological parameters such as number of rainy days, monthly cumulative rainfall, minimum and maximum relative humidity and temperature corresponding to the same study period were collected from the Department of Meteorology, along with the Oceanic Niño Index (ONI) from the National Oceanic and Administration (NOAA) Centre. All the data were arranged at monthly level. After evaluation of the normality, seasonality, stationarity and seasonal stationarity of the epidemic data, a Seasonal Autoregressive Integrated Moving Average (SARIMA) model was fitted for the prediction of dengue by using the R statistical package. Subsequently, the meteorological factors and the dengue incidence was subjected to a cross correlation analysis to identify the most representative meteorological factors associated with dengue epidemic incidence and an Autoregressive Integrated Moving Average with Exogeneous Input (ARIMAX) model was fitted. The best fitted SARIMA (0, 1, 0) (3, 0, 0)12 model was characterized by an Akaike Information Criteria value (AIC) of -19.04, Bayesian information criterion (BIC) of -5.42, Mean error (ME) of 0.002 and Root Mean Square Error (RMSE) of 0.518. According to the cross correlation analysis, number of rainy days (RD) and Oceanic Niño Index (ONI) denoted a significant negative association with the reported dengue cases in Colombo, while monthly cumulative rainfall (RF), maximum relative humidity (Max_RH), maximum temperature (Max_T) and minimum temperature (Min_T) shared a positive correlation ($P < 0.05$ at 95% level of confidence). The best fitting ARIMAX model (as indicated below) was characterized by an AIC of -15.74, BIC of -11. 2, ME of 0.006 and RMSE of 0.171.

ARIMA (0, 1, 1) + [$-0.0006\ RD_{t-3} + 0.0008\ RF_{t-3} + 0.0260\ Max\_RH_{t-3} + 0.0766\ Min\_T_{t—4} - 0.0661\ ONI_{t-5}$]

Based on the performance, the ARIMAX model is recommended to be used for the prediction of dengue incidence in the Colombo district to ensure rational allocation of resources for vector control and dengue epidemic management.

Keywords: "Dengue, prediction, time series, ARIMA, ARIMAX, Colombo"

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