A Time-Series Analysis of the Incidence of Leishmaniasis Integrated with Climatic Variables in Kurunegala District, Sri Lanka

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Leishmaniasis is one of the main health considerations in the tropical areas of the world. The disease is caused by the parasites of genus *Leishmania,* which is transmitted from one host to another through female Phlebotomine sand flies. The information on the correlation between weather conditions and leishmaniasis in Sri Lanka is limited. However, studies from other tropical countries suggest that leishmaniasis is highly influenced by climatic variables, but the nature and magnitude of these effects may differ from one geographical region to another. In the current study, we conducted a time series analysis of the number of patients reported from Kurunegala District of Sri Lanka integrating climatic factors as external regressors. Monthly reported cases of lesihmaniasis from January 2014 to December 2018 in Kurunegala District were tracked from the Regional Director of Health Services (RDHS) office. The climatic factors recorded from regional Agro meteorological stations in Kurunegala District were obtained. A time series of the number of patients was created using "tseries" package of R statistical software. The variance of the time series was stabilized by log transformation. The "forecast" package of R software was used to generate an ARIMA model. Resulting model was slightly changed based on the partial autocorrelation function (PACF) plot, the autocorrelation function (ACF) plot, and the number of differences required to achieve the stationarity of the time series. These models were assessed by Akaike information criterion for goodness-of-fit. Spearman's rank correlation and cross-autocorrelation tests were performed to assess the associations between the number of patients and climatic variables at different lags. The most associated lags of each factor was used as external regressors in a multivariate ARIMA model to assess the effects of climatic factors on the predictive power of the model. The application of "auto.arima" function of forecast package to the log transformed and differenced time series of the number of patients resulted in the model ARIMA (1,1,0), which is also the selected model as it had the lowest AIC among the models generated by changing the values of autoregressive (p), integrative (d), and moving average (q) terms of the model. The time independency of the residual series according to the Ljung–Box test further confirmed the suitability of this model for forecasting. The maximum temperature and the relative humidity were positively correlated with the occurrence of leishmaniasis at 1 and 3 months' lag periods respectively, which can be plausibly explained by the conditions being favorable for vector sand flies and the climate driven changes in host immunity. However, the integration of climatic factors did not increase the predictive power of the model, indicating the possibility of a latent interaction effect between the climate and the regressing terms (AR and MA) of the model or a stochastic mechanism of interactions between weather factors and leishmaniasis incidence Therefore, the climatic factors, despite their effects on the disease incidence, cannot be used to improve the predictive power of the ARIMA model.

Keywords: Leishmaniasis, Time series, ARIMA, Climate, Sri Lanka

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