

Quantifying transmission and identifying factors associated with the malaria outbreak in Venezuela

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Venezuela is currently in a humanitarian crisis, stemmed by high inflation rates and decreasing economic security. The political and economic instability has caused a food shortage and the re-emergence of infectious diseases, including malaria, a disease previously eliminated in Venezuela in 1977. However, malaria had resurged since 2015 and continues to spread, due to the migration of workers to and from gold mines along the border of Guyana. Large proportions of the population are also leaving Venezuela, and the effect of this out-migration on the spread of malaria in other countries is unknown.

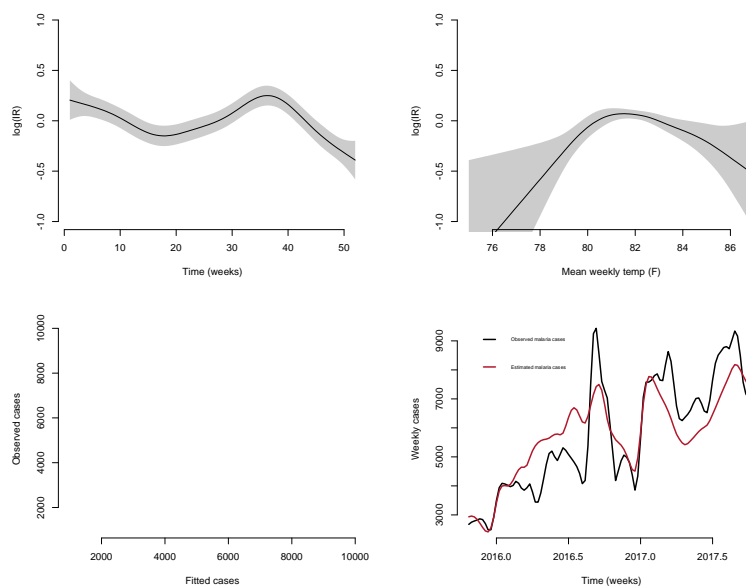


Figure 1. Economic and seasonal factors associated with weekly malaria incidence rates (95% CI are shaded), observed and estimated cases, and estimated cases over time.

Understanding the characteristics of the outbreak and the extent of its spread has been challenging because the government of Venezuela have stopped publicly reporting on the outbreak since the 42nd week of 2017. Here we provide summary of factors associated with the malaria outbreak, and assess the effect of imported cases from Venezuela on malaria transmission in the Colombia. We estimated of incident malaria cases occurring in Venezuela from the 43rd week of 2017 to the 35th week of 2018 (i.e. the time period since weekly reported surveillance stopped), using a Poisson regression model. We examined temporal, economic (inflation rate), and climatic variables (temperature, rainfall, and precipitation) as linear and spline terms using a generalized additive model. Increases in the exchange rate were associated with a 19% (IR: 1.19, 95 CI: 1.15, 1.24) increase in the weekly incidence rate of malaria after adjusting for time and mean weekly temperature (Figure 1). Our model used a spline term for weeks, average weekly temperature, and weekly exchange rates had the highest R^2 ($R^2=0.68$). An ARIMA model was also applied to weekly malaria cases to forecast weekly malaria cases in 2018. We also used case and out-migration data to estimate the contribution of cases imported from Venezuela towards local transmission in Colombian provinces. Our analyses provide a quantitative examination of the current malaria outbreak, both within Venezuela, and its impact on neighboring countries.