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Impact of Air Temperature and SST Variability on Cholera Incidence in Southeastern Africa, 1971-2006

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The most important climatic parameter related to cholera outbreaks is the temperature, especially of the water bodies and the aquatic environment. This factor governs the survival and growth of *V. cholerae*, since it has a direct influence on its abundance in the environment, or alternatively, through its indirect influence on other aquatic organisms to which the pathogen is found to attach. Thus, the potential for cholera outbreaks may rise, parallel to the increase in ocean surface temperature. Indeed, recent studies indicate that global warming might create a favorable environment for *V. cholerae* and increase its incidence in vulnerable areas.

Africa is vulnerable to climate variability. According to the recent IPCC report on Africa, the air temperature has indicated a significant warming trend since the 1960s.

In recent years, most of the research into disease vectors in Africa related to climate variability has focused on malaria. The IPCC indicated that the *need exists* to examine the vulnerabilities and impacts of climatic factors on cholera in Africa.

In light of this, the study uses a Poisson Regression Model to analyze the possible association between the cholera rates in southeastern Africa and the annual variability of air temperature and sea surface temperature (SST) at regional and hemispheric scales, for the period 1971-2006.

Data description is as follows:

1. Number of cholera cases per year in Uganda, Kenya, Rwanda, Burundi, Tanzania, Malawi, Zambia and Mozambique. Source: WHO Global Health Atlas - cholera.
2. Seasonal and annual temperature time series:

Regional scale: a) Air temperature for southeastern Africa (30˚E-36˚E, 5˚S-17˚S), source: NOAA NCEP-NCAR; b) Sea surface temperature, for the western Indian Ocean (0-20˚S, 40˚E-45˚E), source: NOAA, Kaplan SST dataset.

Hemispheric scale (for the whole Southern Hemisphere): a) Air temperature anomaly; b) Sea surface temperature anomaly. Source: CRU, University of East Anglia.

The following Poisson regression model is suggested:

$\log\{E(CHOL_t)\} = b_0 + b_1 \times X_t + b_2 \times X_{t-1}$

where:

$CHOL_t$ = the number of new cases of cholera in year t

X_t / X_{t-1} = the climate covariate measured in year t/t-1.

(b_0, b_1) = the coefficients.

A first order autocorrelation, AR1 = $cor(Y_t, Y_{t-1})$ is taken into account in the estimation using Generalized Estimating Equations.

b_1 and b_2 quantify the association of CHOL and X, i.e. if X_t or X_{t-1} increase by one unit, the mean of Y_t is expected to increase in $\exp\{b_1\}$ or $\exp\{b_2\}$ times, respectively (multiplicative model).

The results showed a significant exponential increase of cholera rates in humans during the study period, with an estimate of $\exp(b_1)=1.08$ (p-value = 0.02). Associations have been found between the annual increase of the air temperature in southeastern Africa and the cholera incidence in the same area. Linkages were found also for a wider scale, with the air temperature anomaly of the Southern Hemisphere, with an estimate of $\exp(b_1)=1.18$ (p-value = 0.04) and $\exp(b_1)=1.26$ (p-value = 0.006) for the previous year.

Significant linkages were detected between the annual cholera rate and the annual western Indian Ocean' SST , with $\exp(b_1) = 1.31$ (p-value = 0.01) for the current year and $\exp(b_1) = 1.23$ (p-value = 0.05) for the previous year. Linkages were found also for the hemispheric scale, with the SST anomaly.

The increase of global temperature may influence the temporal fluctuations of cholera, as well as potentially increasing the frequency and duration of its outbreaks. Despite future uncertainty, the climate variability has to be considered in predicting further cholera outbreaks in Africa. This may help to promote better, more efficient preparedness.

For more details:

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