Comment

Global warming and socioeconomic conditions
Comment on "Modeling the impact of global warming on vector-borne infections" by Eduardo Massad, Francisco Antonio Bezerra Coutinho, Luiz Fernandes Lopez and Daniel Rodrigues da Silva

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The review by Massad et al. dealt with global warming and vector-borne infections [1], in which they did not only present a mathematical model, but explained step by step all terms that appeared in the equations. The non-autonomous model was applied to malaria and dengue infections, obtaining the time dependent threshold for transmission $R(t)$, which was studied by the sensitivity analysis. The authors have made numerous important contributions in this area.

Two features of the model deserve some comments. The model considered a time-delay only in the passage from susceptible to infectious mosquitoes. The extrinsic incubation period depends strongly on temperature [2], as well as the transition time from egg up to adult mosquito [3], while the intrinsic incubation period (negligible compared to long life of humans) apparently does not depend on temperature. Neither the incubation period (humans are lead directly from susceptible to infectious stage) nor the transition time of aquatic phase were considered in the model, but the authors privileged extrinsic incubation period in their model through the time-delay. This choice can be understood as aiming to retrieve the formulae proposed by Macdonald for R_0 [4]. With respect to the seasonal variation, this effect was allowed only to 'mosquitoes production from eggs'. The authors considered a constant fraction per time p_s describing the surviving on aquatic phase and becoming adult. The introduction of seasonality in the model is not clearly justified, because this is not related to any entomological parameters, as well as the step function θ seems artificial. Instead of interpreting the forcing parameters c and d as describing the durations of summer and winter seasons, the forcing term should be linked with the temperature dependent transition rate from eggs to adult (redefining p_s). Allowing to the temperature be dependent on time, $T(t)$, the parameters c and d can be fitted from a time-series data [5], e.g., $T(t) = c + d \sin(\frac{2\pi}{365} t + \phi)$, and the function θ arises naturally through the lower and upper bounds of temperature at which transition from aquatic phase to adult can occur [3]. Therefore, all entomological parameters used by the authors can be set depending on the function $T(t)$ (in some extent they did it in the last model): r_M, τ_I and μ_M, which are, respectively, intrinsic oviposition rate, extrinsic incubation period and mortality rate of mosquitoes.

The authors obtained several valuable epidemiological results from the model. One of the results stated that endemic malaria transmission is established when the temperature is above a threshold value. They estimated the threshold temperature as 26.5 °C, and below this temperature epidemic malaria can occur. A study considering dengue transmission, however, showed that the optimal range of dengue transmission is situated on the interval 27–30 °C, with the highest risk at around 28 °C [6]. The authors assessed the effect of global warming applying the sensitivity analysis. However, as important as the increase in the temperature is the social and economic conditions [7–9]. The global distribution of per-capita gross domestic product shows a striking correlation between malaria and poverty, and malaria-endemic countries also have lower rates of economic growth [10]. In some situations, a worsening in the socioeconomic conditions contributed more significantly to increase the prevalence of malaria than the increase in temperature (global warming), which was assessed by performing the sensitivity analysis taking into account scenarios regarding to the risk of malaria transmission [11,12].

References

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