MATHEMATICAL MODELING OF THE EFFECTS OF SEASONAL AND ENVIRONMENTAL FACTORS ON ENDEMIC MALARIA

by

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Abstract

Malaria is a vector borne disease that has plagued mankind for long and is one of the top five killer diseases in the world. WHO estimates that about 50% of the world's total populations live in areas where malaria is endemic and as global warming occurs, the disease will spread to more areas. In Africa, malaria accounts for approximately 1.3% of GDP per year thus posing a big challenge to development and the achievement of the MDG.

Kenya is ranked in the top five countries that report highest cases of malaria. About 70% of its total population lives in endemic, epidemic or seasonal malaria transmission areas and an estimated 10% living in areas where the parasite prevalence is estimated to be not less than 40%. Malaria therefore remains a serious risk and its eradication a formidable task. Worldwide, great and varied efforts have and are being made to determine how to control it. Official WHO eradication programs include $GMEP$ (1955), RBM (2008) and $MalERA$ initiative (2008) each with set targets and timelines.

To achieve vision 2030 and the global targets, it is important to strive towards eliminating malaria. This calls for well-thought-out research strategies which must be multi-sectoral and directed to specific areas of need. $MalERA$ initiative acknowledges that new tools, interventions and strategies are required to interrupt transmission and ultimately eradicate the parasite. The initiative further acknowledges modeling as a thematic area. For successful mathematical modeling, important parameters in the transmission of the disease must be understood and models that can predict the impact of variations in key factors formulated. The models developed are then validated using field and epidemiological data.

To understand the transmissibility of the disease we formulate a vector-host compartmental model using DE in which susceptible humans are infected when bitten by an infectious mosquito. They then progress through the exposed, infectious, and recovered classes, before reentering the susceptible class. Susceptible mosquitoes can become infected when they bite infectious or recovered humans. Once infected they move through the exposed and infectious classes. Both species follow a logistic population model, with humans having immigration and disease-induced deaths. Empirical evidence suggests that malaria varies seasonally in endemic areas and is sensitive to long-run climate changes (Grasso *et al*, 2010).

In our study, we seek to develop, and simulate models incorporating the effects of seasonality and changing environmental factors. The validated models may be used to formulate malaria policies, offer guidelines for adapting and implementing those policies as well as assist in evaluating the impact of public-health effects on transmission dynamics. We shall determine the condition for which a disease-free equilibrium is locally asymptotically stable and also prove the existence of an endemic equilibrium point. Bifurcation and numerical simulations shall then be performed.