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Economy-wide implications of climate change-induced malaria in Kenya: Linking a demographic module to a dynamic CGE model

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Climate change is expected to increase the burden of malaria in Kenya by reshaping the environment in ways that affect mosquito populations and disease transmission. These changes risk undermining recent gains in malaria control and could place significant pressure on both the health sector and the whole economy. This study applies an integrated modelling framework to explore the medium- and long-term economic impacts of climate-related malaria in Kenya. It combines a demographic module, which captures malaria-related mortality by age and gender, with a recursive-dynamic single-country Computable General Equilibrium (CGE) model calibrated to Kenya's 2022 Social Accounting Matrix (SAM). The model depicts how malaria affects labour supply and productivity, considering different epidemiological zones. In addition to the baseline scenario, two counterfactual scenarios are developed, capturing changes in mortality and morbidity (among adults and children) determined using data generated by malaria forecasting and hydrometeorological models. The findings indicate substantial adverse effects on economic growth and household welfare, particularly for the most vulnerable communities. Quantifying these risks offers valuable insights for Kenya's climate adaptation and malaria control and elimination strategies.

Keywords: Climate change, Malaria, Health and economic impacts, CGE analysis, Kenya

1. Background

Climate change could significantly modify the prevalence and distribution of vector-borne diseases, e.g., malaria (Diouf et al., 2022; Leal Filho et al., 2023). This alteration in transmission dynamics will be driven by changes in rainfall patterns, humidity, and temperature-related factors, affecting Anopheles mosquitoes and Plasmodium parasite development (Karypidou et al., 2020). Consequently, there will be shifts in suitable geographic locations for transmission and variations in season lengths (Ryan et al., 2020), possibly undoing the progress of malaria control programs and heightening the risk of malaria (Mordecai et al., 2020). Additionally, population displacement resulting from climate-induced factors may contribute to elevated malaria cases as individuals lacking immunity migrate to endemic areas (WHO, 2023).

Malaria continues to impose a substantial health and economic challenge in Kenya. Over the last decades, the Kenyan government has implemented strategies to control and eliminate malaria, improving access to insecticide-treated nets, malaria-prevention medications, and the malaria vaccine (KMoH, 2020; WHO, 2023). Despite these intensive interventions, malaria continues to impose a significant burden of morbidity and mortality in the country, with approximately 3.5 million cases and 10.700 deaths reported in 2022 (WHO, 2023). Nevertheless, the overall population at risk of malaria is anticipated to increase under climate change (WHO, 2023). This event necessitates allocating additional resources and implementing more strategies to eliminate malaria, considering the country's varying levels of malaria prevalence.

Rising malaria prevalence attributable to climate change can directly influence population demographics and human well-being. This impact extends to labour availability (through changes in mortality) and labour productivity (through changes in morbidity), ultimately affecting the overall economy. This outcome holds particular significance in Sub-Saharan African countries, where labour is a crucial household income source and production factor, with limited substitution potential by capital endowment.

This study aims to assess the potential economy-wide effects of climate change-induced malaria on mortality and morbidity in Kenya, considering various malaria epidemiological zones.

2. Methods

A social accounting matrix (SAM) is developed for Kenya for 2022, including data related to malaria epidemiological zones. These zones include: a) malaria-free, b) very low risk, c) low risk, d) low-moderate risk, e) moderate risk, and f) high endemic. This SAM is updated and extended based on data from the 2019 SAM for Kenya (Elnour et al., 2022) and domestic sources, including the Kenya National Bureau of Statistics (KNBS, 2023), the Kenya Ministry of Health (KMoH, 2023), and the Central Bank of Kenya (CBoK, 2021).

The SAM includes eleven production sectors, three of which are agricultural. Labour is classified into 18 categories, reflecting three skill levels (skilled, semi-skilled, and unskilled)

across six malaria epidemiological zones. Households are further disaggregated into 24 groups based on location (urban or rural), income status (poor or non-poor), and the same six malaria zones.

We developed a demographic module that computes changes in population demographics resulting from alterations in malaria-induced mortality. This module classifies the population by gender and age, which allows us to determine the changes in the labour force. We integrated this demographic module into a recursive-dynamic single-country CGE model, namely STAGE version 3. The labour supply is calculated, considering malaria's effects on adult and child morbidity.

In addition to the baseline scenario, two counterfactual scenarios will be constructed to illustrate changes in mortality and morbidity (among adults and children) resulting from climate change-induced malaria. Mortality and morbidity rates will be computed using data generated by malaria forecasting and hydrometeorological models. These models account for changes in malaria incidences and deaths, resulting from variations in temperature, precipitation, and other relevant climate variables.

3. Expected results

This study aims to assess the impacts of climate change-induced malaria on Kenyan economic growth and household welfare over the medium and long run. The findings provide valuable insights for Kenyan policymakers, enabling them to craft and implement effective strategies and policy measures that alleviate the enduring negative impacts of climate change-induced malaria. The goal is to improve livelihoods and foster sustainable development in the country.

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