Swiss TPH
Swiss Tropical and Public Health Institute
Schweizerisches Tropen- und Public Health-Institut
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Associated Institute of the University of Basel

Assignment:

Simulation of impact of interventions in Tanzania using OpenMalaria

Malaria background:

Plasmodium falciparum malaria remains the most important parasitic disease of humans. This is despite the availability of a range of preventive and therapeutic interventions including mosquito nets, house spraying, repellents, chemotherapy, and possibly vaccines. These interventions can be deployed in different ways, singly and in combination, but it is not obvious which of many different strategies to invest in, particularly when resources are limited, as they usually are in the low income settings where malaria is found.

Case study:

We are considering implementing new intervention strategy in the country in order to reduce malaria transmission and burden by 2030. There is a need to simulate the impact of various interventions in order to provide evidence for the country program to decide what strategy they should adopt. The considered interventions are as follow:

- An improvement in access to treatment
- Distribution of bed nets
- Spraying of indoor residual (IRS)
- Vaccine (introduced together with BCG vaccine)

The program would like to receive quantitative evidence of the impact of the interventions deployed alone or in combination.

Description of the interventions:

An improvement in access to treatment would involve an increase in the percentage of fevers treated of 20% from baseline in 2025. The cost per treatment would be 1 USD for uncomplicated case and 28 USD for severe case.

Distribution of bed nets would happen in 2025 and 2028 at the same coverage it has historically been deployed (and used). The duration of nets would be around 3 years. The cost for bednets is 2 USD per person protected and per campaign.

The spraying of indoor residual insecticide would happen annually starting in 2025 at the same coverage than it had been implemented historically. The impact of IRS would last approximately 3 to 6 months, so would be deployed right before the malaria transmission season. The cost for IRS would be 3 USD per person protected and per campaign.

The vaccine would be introduced to children at the same time of the BCG vaccine (for tuberculosis) when children are around 6 months. The vaccination campaigns would start in 2025. The cost per child vaccinated and per year would be around 50 USD.

Overall expectations:

This assignment serves both as an assessment of your problem-solving, data analysis and programming skills and as an introduction to you to the type of work applied modellers are often facing.

You will be expected to extract the necessary information from various documents in order to parameterize OpenMalaria and run the simulations for various scenarios of strategies. At the end you will analyse these results in order to formulate a recommendation to the policy makers of Tanzania (2-4 pages report) in terms of what strategy they should be implemented, considering the public health impact as well as the cost.

Organization:

You will be working in pairs (7 groups). Each pair will perform the analyses for a different region, as indicated below:

Group	Region
1	Tanga
2	Morogoro
3	Simiyu
4	Geita
5	Mara
6	Kagera
7	Tabora

Description of the tasks to perform:

Step 1: Data extraction and model parameterization

Step 2: Model fitting

Step 3: Simulation of future interventions

Step 4: Cost-benefit analysis

Step 5: Dissemination

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Step 1: Data extraction and model parameterization

For each of your region you will need to extract the following information in order to parameterize the model:

- Proportion of children with fever who were treated with an ACT
- Prevalence of malaria in children (and type of diagnostic)
- Rainfall patterns
- Proportion of children under 5 who slept under an ITN
- Coverage of IRS - How should we define it for the model?
- BCG vaccine coverage
- Population in your region in 2022
- Number of total cases in 2022

Not all information is available at the regional level. In this case, use the values for another region or at national level, depending on what makes more sense.
Use the most recent value in case there are any conflict.
Don't forget to keep track of your sources.
The following documents are available:

- Demographic and Health Survey 2022
- End of spray report 2022 from PMI
- Average monthly rainfall extracted from Worldclim
- Administrative units Population Distribution Report Tanzania
- World Malaria Report 2023

Step 2: Model fitting

In this section, the objective will be to find the EIR value that will correspond to the prevalence you have extracted. (This is manual model fitting).

Using all the other information you extracted and the relevant age structures, reproduce your region as well as you can in VecNet. Do not remove interventions nor timesteps, just modify coverages.
Test different values of EIR until you obtain (roughly) the observed prevalence in 2022.

Timestep	Year number for survey output	Year
146	3	2022
219	4	2023
292	5	2024
365	6	2025
438	7	2026
511	8	2027
584	9	2028
657	10	2029
730	11	2030

Hints:

- The rainfall patterns can be used as a proxy for transmission patterns. You can assume transmission happens a month after rainfall – You will need to modify directly in xml under EIR monthly values
- Children under 5 can be used as a proxy for general population
- Assume nets were distributed in 2022
- Use the age structure you chose to determine the denominator for your prevalence.
- Don't forget the type of diagnostic!

Step 3: Simulation of future interventions

In this section you will simulate the impact of various strategies of intervention.

1. For each intervention, write down the two different levels that this intervention can have, together with their coverage levels. (e.g LLIN is either no (coverage=0%) or yes (coverage= 80%)
2. Write down all the different combinations of interventions that can be simulated with these 4 interventions and 2 levels for each.

3. Simulate all the different combinations of interventions using the set-up you had created for baseline with your selected EIR.
4. Calculate your appropriate indicators for comparison: EIR, prevalence and incidence.
5. Visualise and compare the different intervention mixes and determine the most impactful strategy. Comment on the magnitude of impact in comparison with the other strategies.

Hints:

- Don't forget to add the epidemiological indicators you think you will need for the impact on transmission and **burden** and therefore for the cost-effectiveness evaluation
- For case management, use the changeHS in xml
- For the analysis you can use R or the excel template provided or any other software for analysis and visualisation.

Step 4: Cost-benefit analysis

1. For each combination of intervention, calculate the associated cost that correspond to each mix of strategy.
2. Using the impact of the intervention mix calculated at step 2, determine the cost effectiveness for each intervention mix.
3. Compare the different intervention mixes and determine the most cost-effective strategy. Comment on the magnitude of the cost-effectiveness in comparison with the other strategies.

Step 5: Dissemination

You will be expected to:

1. Report your analyses and results in a 10-12 min presentation to the class on Friday.
2. Report your analyses and results in a 2-4 page document that is intended to be presented to policy-holders where you will formulate your recommendations.

Hints:

- Don't forget to include your thoughts about the technical limitations of this approach
- Also share your opinion about the advantages and limitations on the use of such outputs to support national malaria control programs
- We will be especially interested in your thought process and how you analyzed and presented the results.