

# MODEL DEVELOPMENT FOR TUBERCULOSIS SPREAD FROM ONE REGION TO ANOTHER

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Objective: Predicting the spread of tuberculosis from one region to another.

Methodology:

This model is built based on the assumptions of the famous gravity and SIR models and is designed to predict the spread of tuberculosis from one locality to another, the mathematical framework is presented below:

$$R_{ijt} = f_t(P_i, P_j, D_{ij}, SCI_{ij})$$

$$R_{ijt} = \frac{P_i^a P_j^b SCI_{ij}^c}{D_{ij}^r} + e_{ij}$$

$$R_{ijt} = -s(t) - r(t) = i(t) \quad \text{From the SIR model}$$

$$r(t) = \frac{dr}{dt} = kI, \quad s(t) = \frac{ds}{dt} = -mSI, \quad i(t) = \frac{di}{dt} = mSI - kI$$

Hence

We have our final model to be,

$$R_{ijt} = (m - k)(SI - I) = \frac{P_i^a P_j^b SCI_{ij}^c}{D_{ij}^r} + e_{ij}$$

Hence it is enough to estimate

$$(SI - I) = Z \frac{P_i^a P_j^b SCI_{ij}^c}{D_{ij}^r} + e_{ij}$$

With

$$Z = \frac{1}{(m - k)}$$

### **Variables definition:**

$R_{ijt}$  = Rate of spread of Tuberculosis from region  $i$  to region  $j$

$P_i$  = population of TB patients in region  $i$

$P_j$  = total population of people in region  $j$

$SCI_{ij}$  = Social connectedness between region  $i$  and  $j$

$D_{ij}$  = distance between region  $i$  and region  $j$

$S$  = ratio of susceptible individuals to total population in region  $j$

$I$  = ratio of infected individuals to total population in region  $j$

$a, b, c, r, k, m, z$  = model parameters

### **Variables Actualization and model estimation:**

All of these variables can be gotten from the demographic and GIS data of TB patients and non TB patients in various locations, and can work with any set of locations, then the initial target can thus be estimated after estimating the parameters of the final model.

Depending on the region of reference  $i$  and distribution of data, a suitable technique is chosen to estimate the model parameters and tested for accuracy

### **Model Explanation:**

Simply put, this model is designed to estimate a factor that represents how much of impact a region (reference) with TB exerts on another region given the social connectedness between these regions, the distance between these regions,

population of TB patients in reference region, population of people in other regions and amount of susceptible individuals, amount of infected individuals in other regions

### **Illustration:**

Given the above information on two local governments, Yaba and Surulere, this model will estimate the rate at which TB spreads from yaba to surulere and also from yaba to any other local government in Nigeria.

### **Citations**

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