Assessing the potential impact of Men5CV meningococcal vaccine on transmission dynamic of meningitis: An Agent-Based Modelling Approach.

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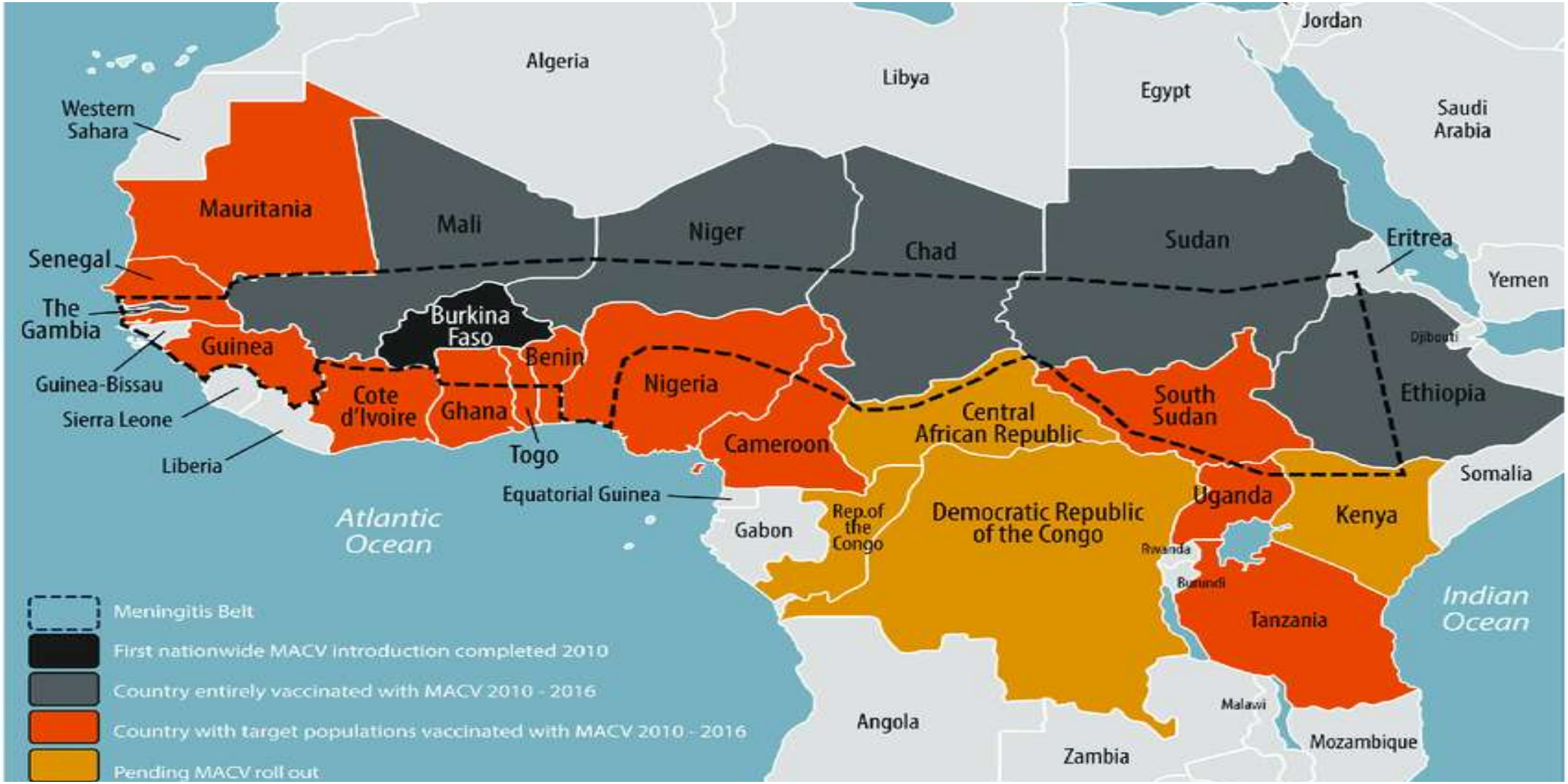
INTRODUCTION



Meningitis Transmission Dynamics

Overview of Meningitis Transmission

- Bacteria transmitted via respiratory droplets (coughing, sneezing).
- Close contact in overcrowded environments (e.g., schools, markets) facilitates rapid spread.

Key Factors Affecting Meningitis Spread

- Population density.
- Vaccination rates.
- Climatic factors (e.g., dry, dusty conditions).

Research Gaps

- Recurring meningitis outbreak in Nigeria despite ongoing vaccination efforts where existing epidemiological models fail to capture the complexities of meningitis
- Inadequate representation of individual behavior since most studies have used compartmental models which assume homogenous mixing of individuals.
- Impacts of environmental and social factors since current models that have been used did fail to integrate things like seasonal climatic changes

Research Questions

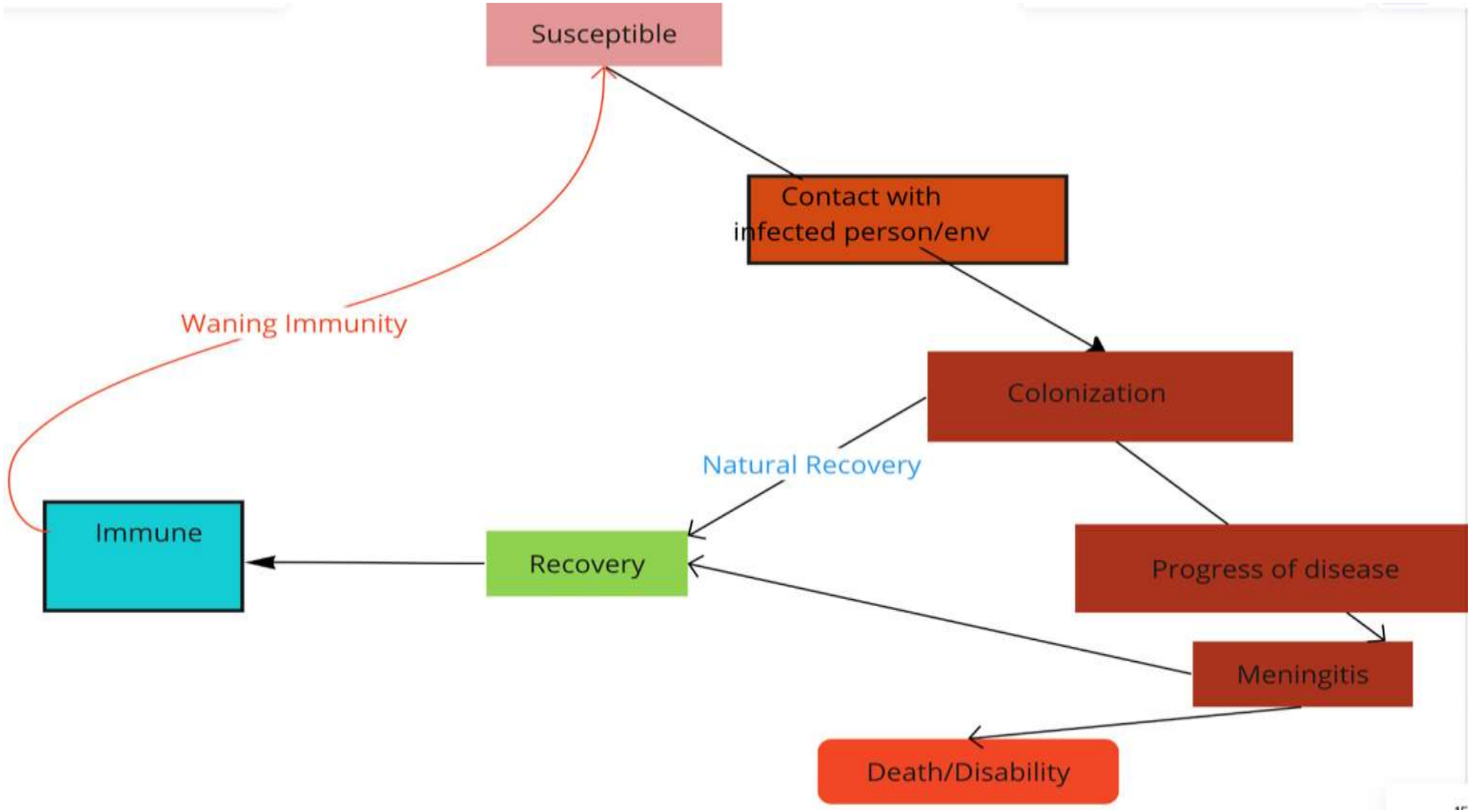
Objective

Estimate the proportion of the population or sub-group should be vaccinated for us to achieve Herd immunity for meningitis in Nigeria by 2030.

Research questions

- How different Men5CV vaccination coverage levels will impact the overall transmission dynamics of meningitis.
- What is the threshold for achieving herd immunity in Nigeria by 2030?
- What is/are the best vaccine strategies (es) to avert new infections?
- Which is/are cost-effective strategies (es) for administering Men5CV vaccine?

Model structure



Methods

Model structure (SVEIDRS)

The ABM model was used to: Model the transmission dynamics, Assessing impact of vaccination and Assessing impact of targeted vaccination on disease transmission

Settings

- Data from the WHO site and literature are used
- We stratified the population based on age.
- **Target population** – The general population of Nigeria all assumed to be susceptible
- **Subgroups** – Age-specific (Aged 9 to 18 months; 1 to 19 years), High-Risk, Geographical regions, Socio-economic status, etc.
- **Time Horizon** - 6 years (2024 - 2030)

Model Implementation

Interventions -

- Vaccine implementation with varying coverage rates/schedules
- Vaccine distribution strategies and prioritization in subgroups

Comparators

- Baseline
- Comparison between different coverage levels and strategies

Heterogeneity

- Impact of the heterogeneous population under study on meningitis transmission dynamics

Model implementation

Model

Literature
SVEIDRS

Implementation

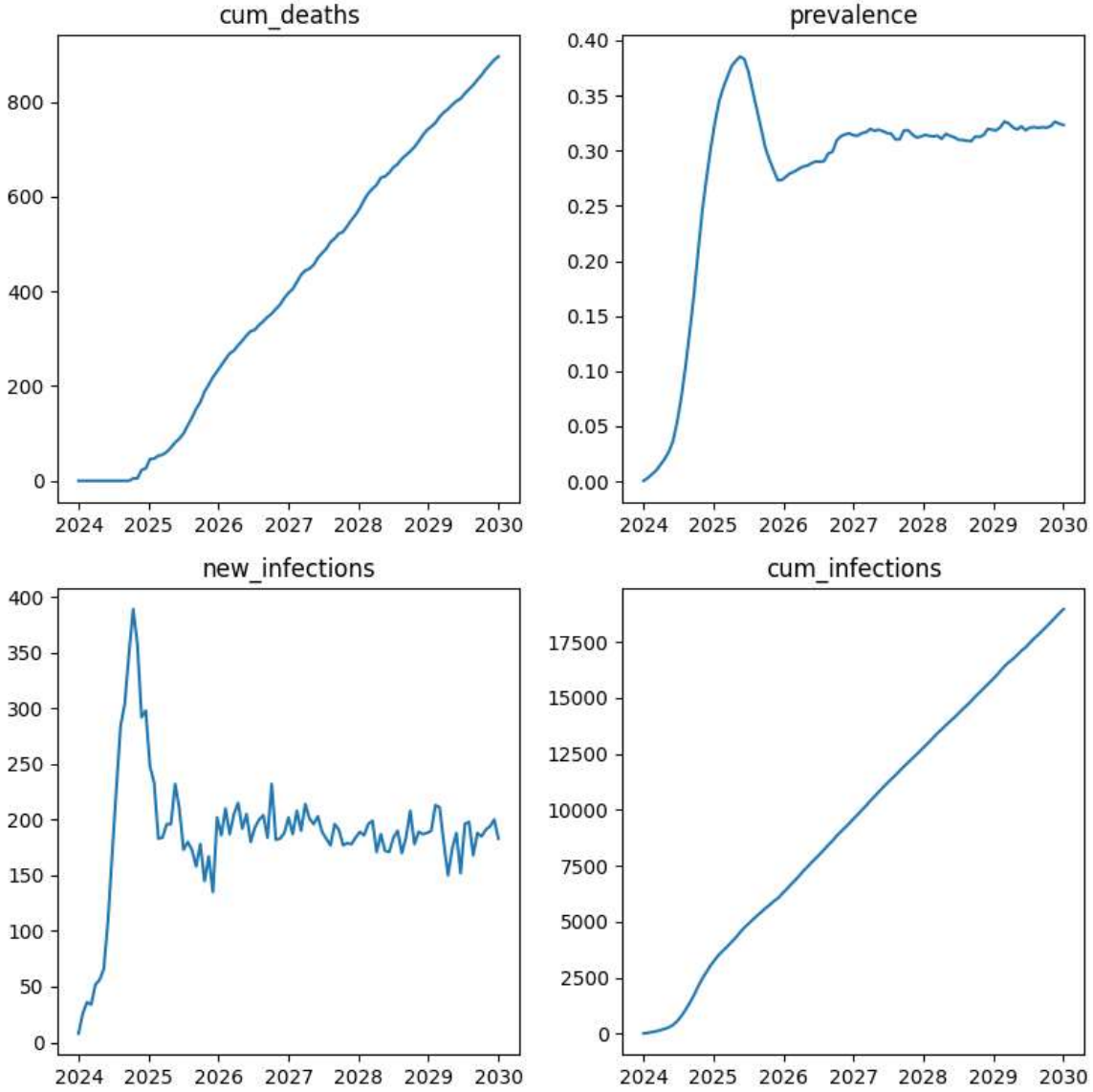
starsim python package

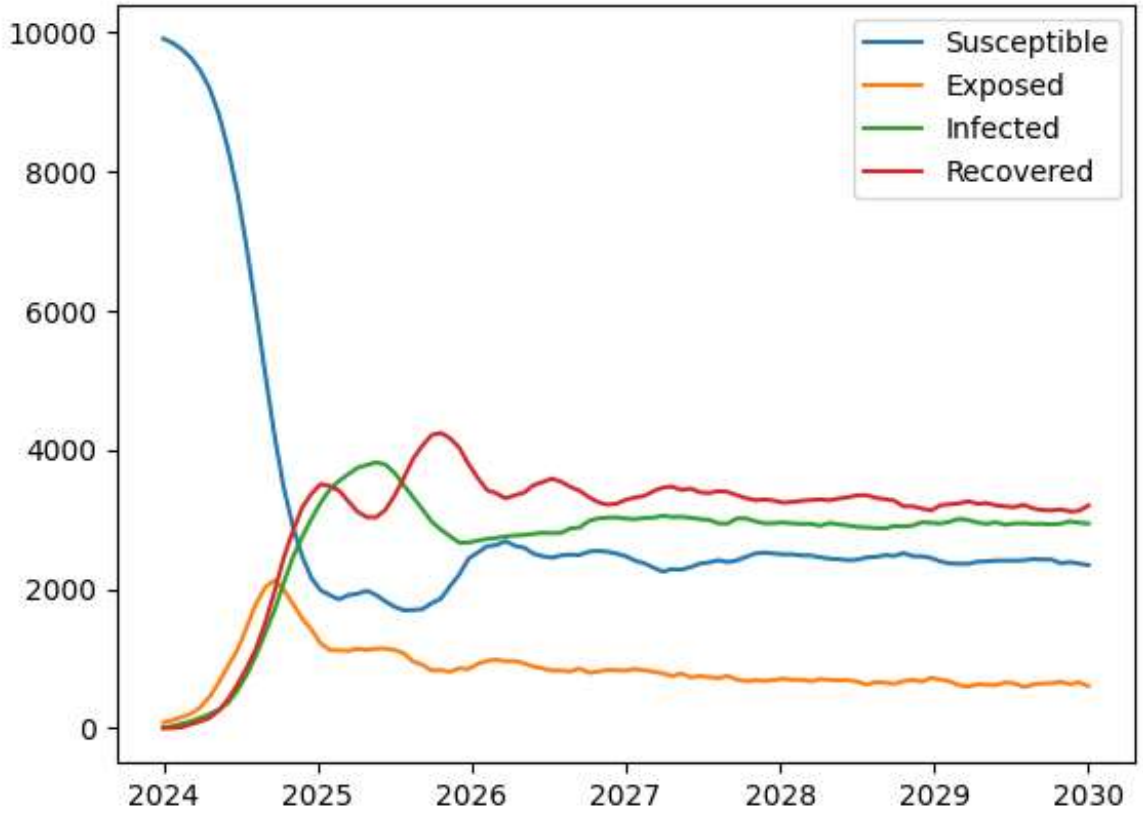
Initial conditions

dur_exp_inf = 2, # (days)
dur_exp_rec = 2, # (days)
dur_inf = 14, # (days)
dur_rec = 7, # (days)
p_death = 0.05, # (prob of death)
p_symptoms = 0.4, # probability of showing symptoms
init_prev = 0.005, # Init cond
beta = 0.08, # Init cond
rel_beta_inf = 0.5, # Reduction in transmission for I versus E
*waning = 1/(365*3),*
imm_boost = 0.001

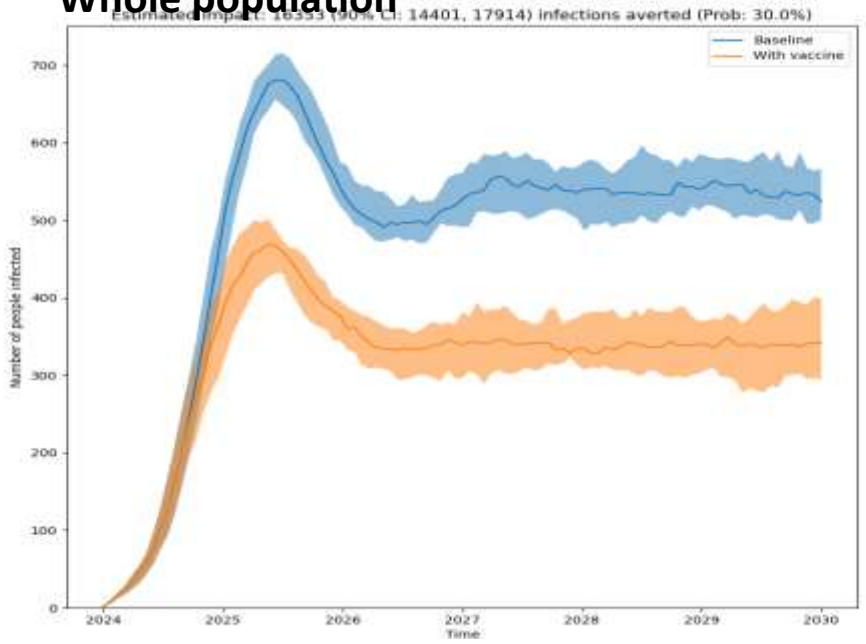
Parameters	Value
Contact rate	0-0.9
Per capita infection rate by Exposed	0.74
Per capita infection rate by Infected	0-0.85
Recovery rate of infected	0.43
Recovery rate of Exposed	0.8
Disease-induced death rate	0.495
Proportion of Exposed that progress to infection	0.3
Rate of progression from Exposed to Infected	0.00022
Lost of immunity	0.851

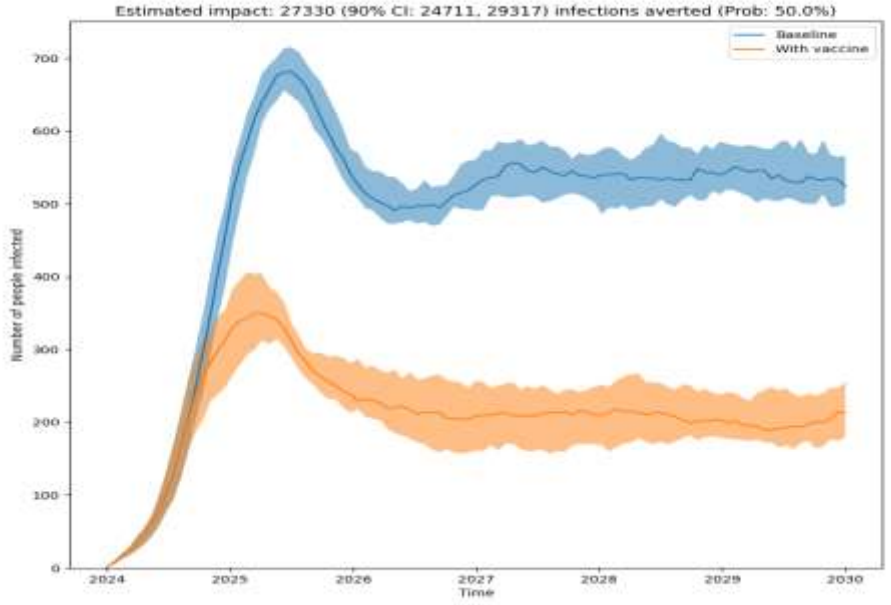
Results


cum_deaths
prevalence
new_infections
cum_infections

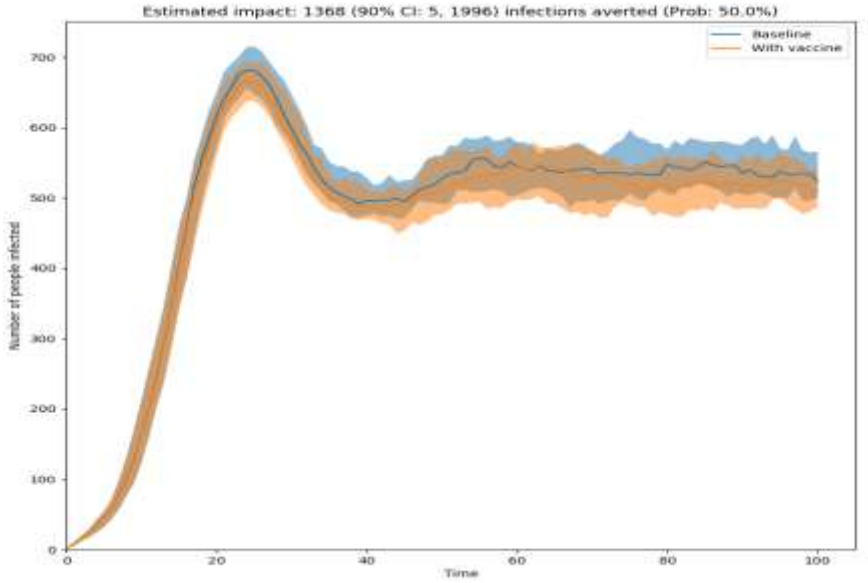

Susceptible
Exposed
Infected
Recovered

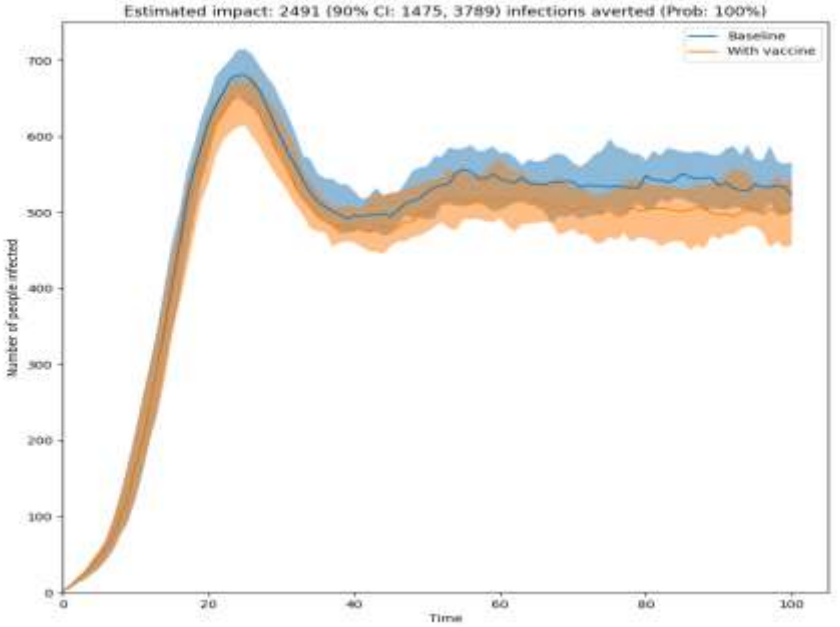
Whole population





Targeted age-group (9 - 18 months)





Discussion and Limitation

Discussion

- There was a significant reduction in disease incidence and transmission rates through vaccination.
- Different vaccination coverage levels and strategies in controlling meningitis outbreaks was insignificant.
- Lack of variability access to age-groups suggest that other factors may play a significant role in the disease transmission dynamics.

Limitations

- Limited baseline data on the contact patterns of the people in Nigeria
- Impact of social network effects and peer influence on vaccination decision

Conclusion and Policy Implication

- The public health system should focus on increasing vaccination coverage among the susceptible population to reduce cases
- Target Vaccination campaigns should be implemented to reach a specific population that is more vulnerable
- Continuous surveillance and monitoring of the disease incidence are crucial to track the impact of vaccination which will lead to the informed decision-making process


Thank you