How Vaccination Coverage Level Impact Cases Observed During Ebola Outbreak in Guinea, Sierra Leone, and Liberia

Presented by
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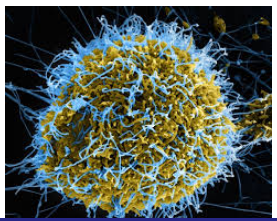
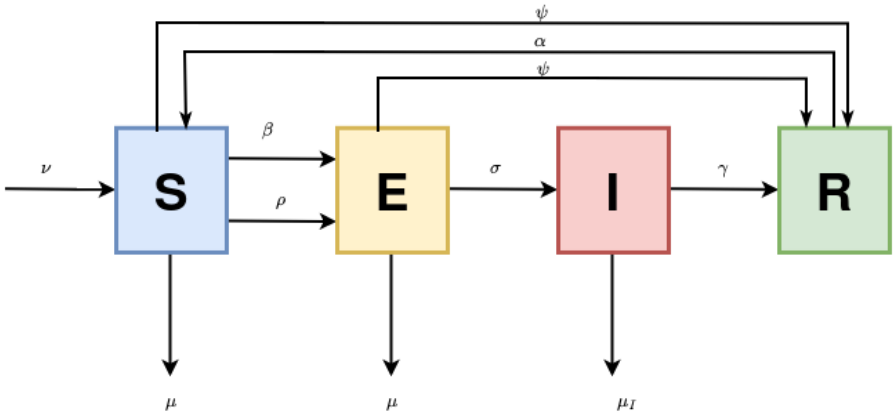


Overview

Introduction

- Ebola, a highly infectious and deadly virus, has significantly impacted Africa, especially during the 2014 outbreak in Sierra Leone, Liberia, and Guinea.
- This study focuses on key aspects such as the basic reproduction number (R_0) and vaccination efforts to understand and manage the epidemic using Mathematical modeling.
- Research Question: How does the implementation of the same vaccination program in different settings affect the number of infections and the spread of Ebola diseases?

Method



The equations below represent the SEIR model of Ebola with vaccination

$$\frac{dS}{dt} = -\beta SI - \rho SR - \mu S + \alpha R - \psi S + \nu \quad (1)$$

$$\frac{dE}{dt} = \beta SI + \rho SR - \sigma E - \mu E - \psi E \quad (2)$$

$$\frac{dI}{dt} = \sigma E - (\gamma + \mu_I)I \quad (3)$$

$$\frac{dR}{dt} = \gamma I - \alpha R + \psi E + \psi S \quad (4)$$

Results

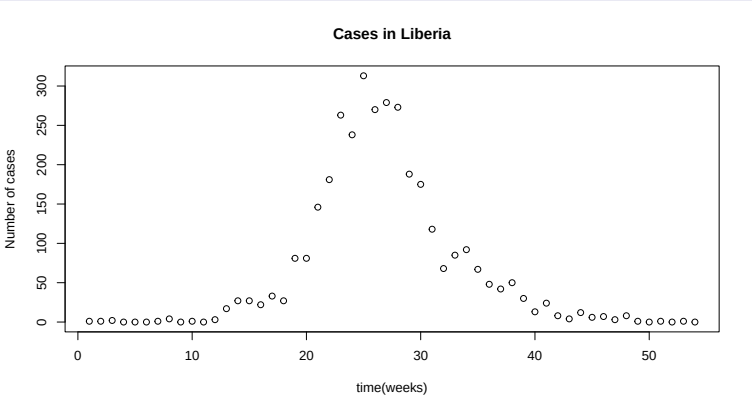


Figure: Plot of epidemic data

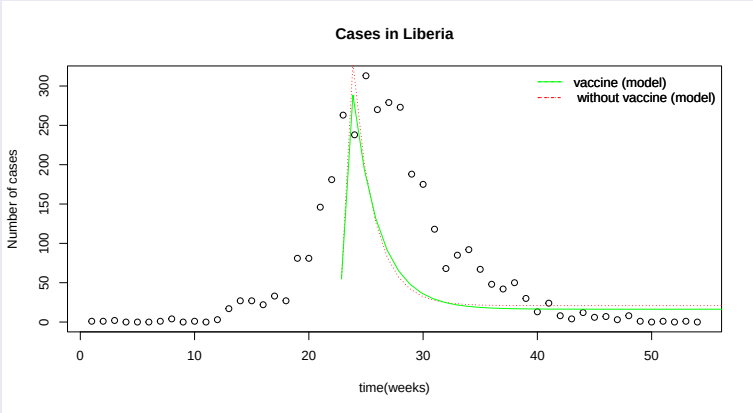


Figure: Model of the cases

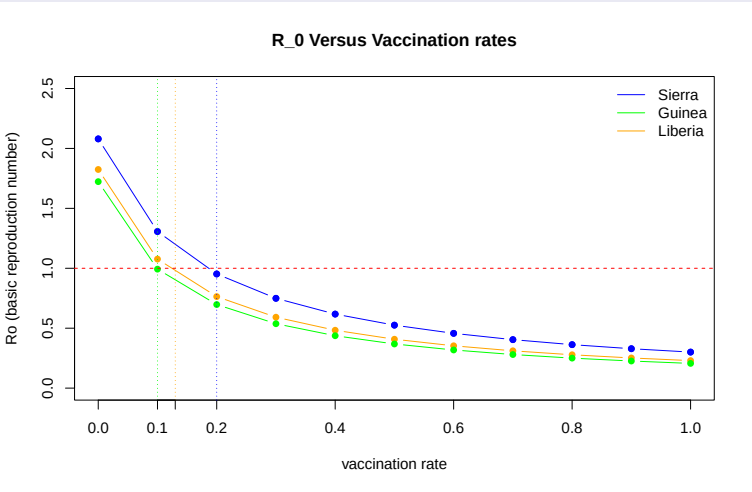


Figure: R_0 vs vaccination rates.

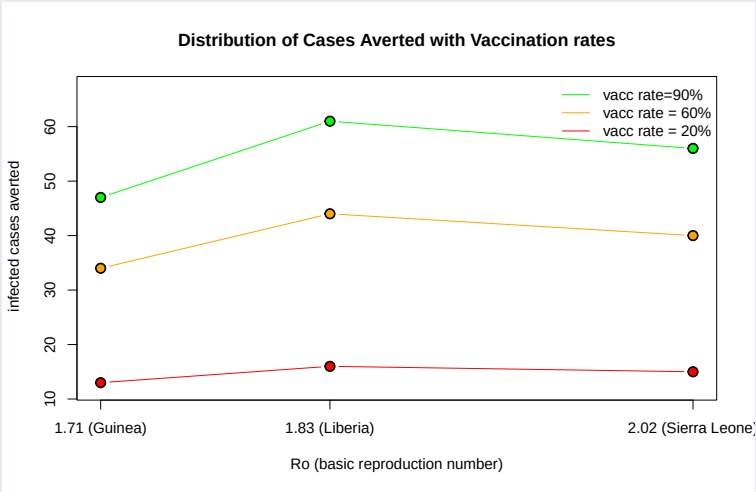


Figure: Cases averted

Results

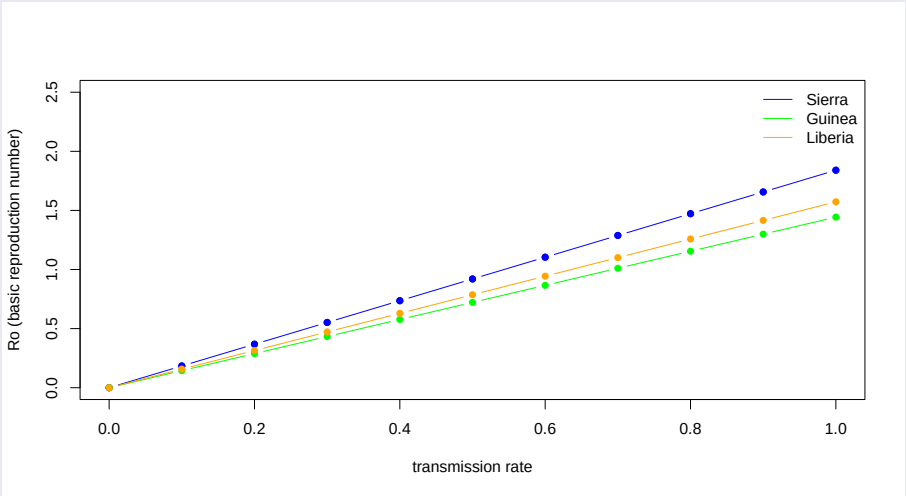


Figure: R_0 vs transmission rates.

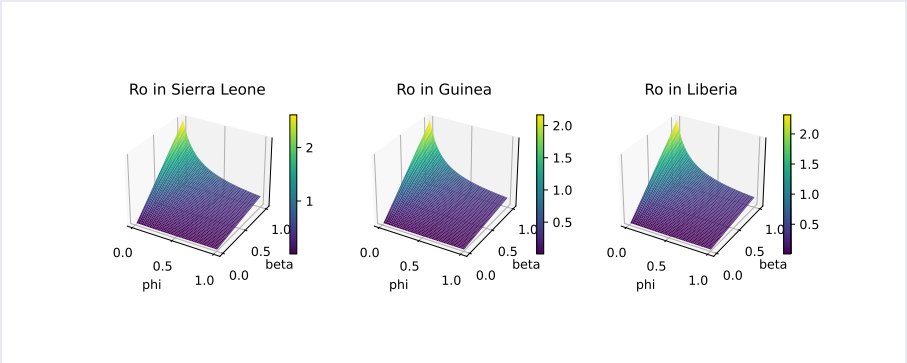


Figure: Variation of R_0

Discussion

- Figure 2 indicates the number of cases in Liberia over time (weeks). It shows the progression and peak of the epidemic.
- Figure 3 compares the modeled number of cases in Liberia with and without vaccination over time (weeks). It illustrates the impact of vaccination on the epidemic curve.
- Figure 4 shows the relationship between the basic reproduction number (R_0) and vaccination rates. It indicates how increasing vaccination rates reduce R_0.
- Figure 5 depicts the distribution of cases averted at different vaccination rates (20%, 60%, and 90%) against the basic reproduction number (R_0). It highlights the effectiveness of vaccination in preventing cases.
- Figure 6 Illustrates the relationship between the basic reproduction number R_0 and transmission rates. It shows how R_0 increases with higher transmission rates.
- Figure 7 plot depicts how R_0 changes with different parameters.

Conclusion

This study shows that vaccination is essential for controlling Ebola outbreaks in different settings. Without vaccination, disease spread would be more widespread, requiring more intervention measures. Vaccination effectively reduces the transmission rate (β), which lowers the basic reproduction number(R_0). This, in turn, decreases the number of susceptible and infected individuals in the population. This highlights the crucial role of vaccination in managing Ebola outbreaks and assessing the success of intervention strategies.

References

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Thank you for your attention