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Mathematical Modeling of Epidemic Spread with Vaccination and Awareness: A Reaction–Diffusion Approach

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INTRODUCTION & AIM

- **Epidemic Modeling:** Mathematical models are essential tools for understanding the complex dynamics of infectious diseases and evaluating control strategies.
- **Intervention Impact:** Vaccination and individual awareness are critical factors in reducing transmission rates and managing outbreaks.
- **Proposed Model:** A reaction–diffusion PDE system is developed to investigate the spatial spread of diseases, incorporating two levels of awareness and a saturated treatment approach.
- **Research Focus:** This work analyzes how spatial diffusion influences Turing pattern formation and the long-term persistence of the disease.
- **Validation:** Extensive numerical simulations are performed to validate the theoretical stability results and illustrate the emergence of spatial structures.

METHOD

We propose a reaction–diffusion epidemic model incorporating vaccination and dual awareness dynamics.

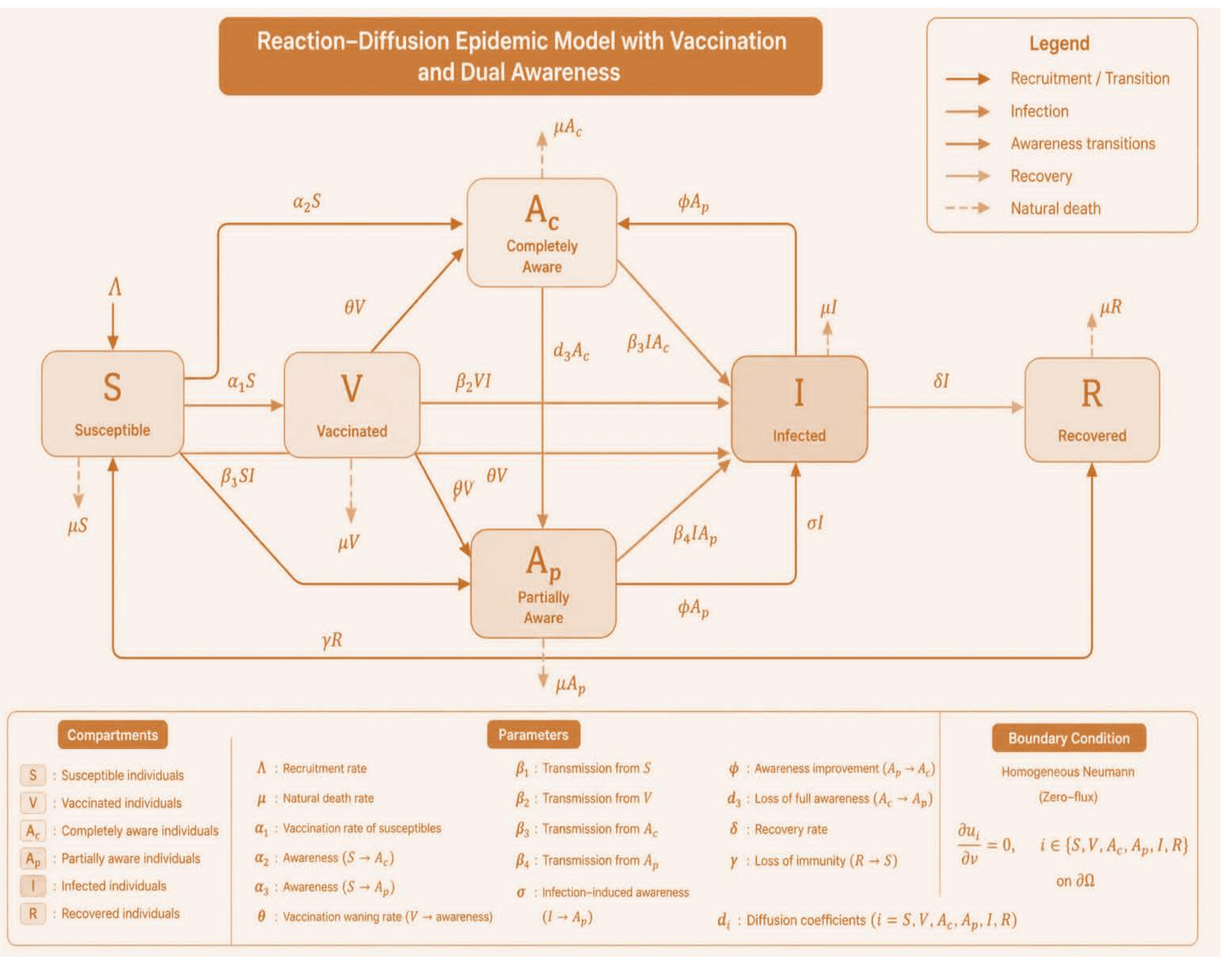

Figure 1:Schematic diagram of the proposed epidemic model

RESULTS & DISCUSSION

- Theoretical analysis shows that the disease-free equilibrium is stable for $R_0 < 1$.
- Numerical simulations validate the analytical results.
- Diffusion induces spatial heterogeneity and pattern formation.
- Vaccination and awareness play a crucial role in reducing the transmission of infectious diseases.
- Turing instability may generate complex spatial epidemic patterns.

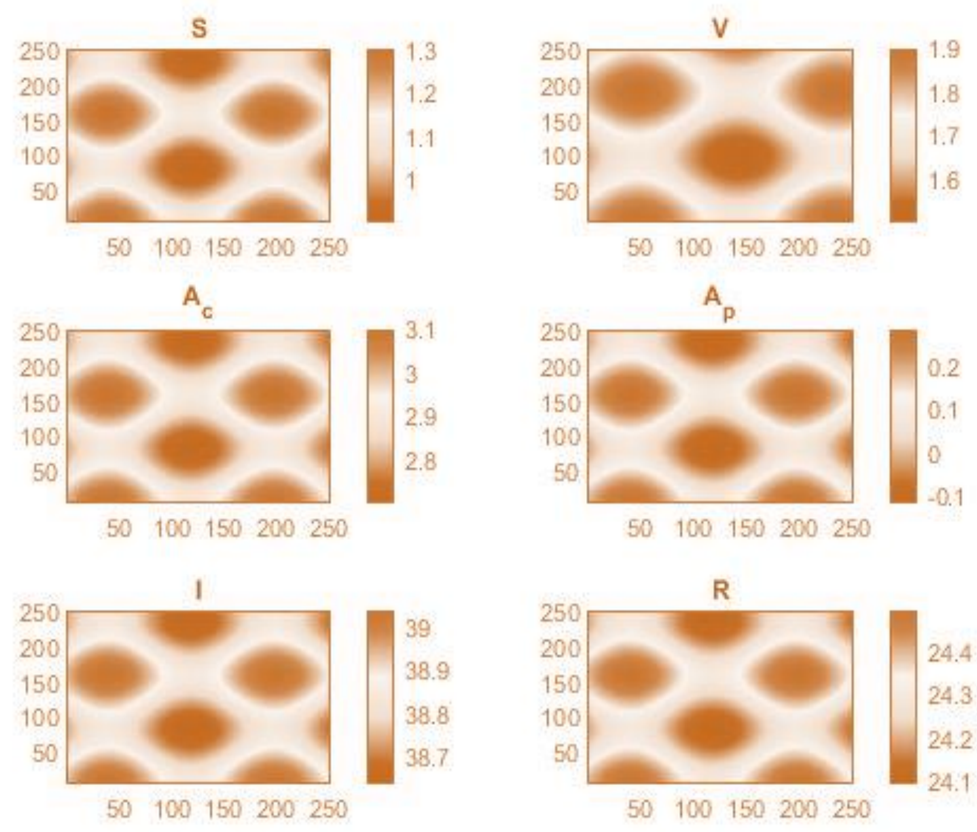

Figure 2: Spatial Turing patterns for the compartments

CONCLUSION

Vaccination and awareness help control disease transmission, while diffusion effects may induce spatial epidemic patterns.

FUTURE WORK / REFERENCES

Future work includes optimal control analysis and extensions of fractional-order reaction–diffusion models.