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Modeling malaria transmission with age structure: Insights from case studies in Senegal

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Malaria remains one of the most significant global health threats, especially in tropical regions. To better understand its transmission dynamics, we propose an age-structured mathematical model incorporating both human and mosquito populations. Our model classifies humans into children and adults, considering distinct infection and immunity dynamics for each group, while also incorporating the life stages of the mosquito population.

First, we perform a mathematical analysis of the model. The stability of the Disease-Free Equilibrium is studied using a matrix-tree theorem, while we analyze the global asymptotic stability of the Endemic Equilibrium via graph-theoretical techniques. Additionally, numerical experiments suggest that our stability results may hold under more general conditions.

To demonstrate the practical relevance of our model, we calibrate it using real-world data from two malaria-endemic areas in Senegal: Dielmo and Ndiop. The results highlight the importance of considering age structure and localized parameters in malaria modeling. This approach provides valuable insights for designing effective control strategies tailored to specific demographic and geographic contexts.

Keywords: epidemiological modeling, malaria, deterministic models
MSC2020: 92D30, 92C60

References

[1] R. Seck, D. Ngom, B. Ivorra, A. M. Ramos, An age-structured mathematical model for studying Malaria transmission dynamics: Applications to some areas of Senegal, *Mathematics and Computers in Simulation*, 229:392–408, 2025.