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A Mathematical Epidemiological Model for Dengue Fever Transmission Incorporating Integrated Public Health Interventions

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Abstract

This work formulates and analyzes a deterministic compartmental model for the spread of dengue fever, incorporating three key intervention strategies: environmental sanitation, early detection of cases, and hospitalization. The model reflects how improved sanitation reduces mosquito breeding opportunities, early detection enhances timely medical response, and hospitalization limits disease severity and potential transmission. A threshold quantity, the reproduction number, is derived to assess whether the infection will persist or decline over time. The qualitative analysis shows that when this threshold is below one $(R_0 < 1)$, the infection cannot sustain itself in the population, whereas values above one $(R_0 > 1)$ indicate possible persistence of the disease [1]. The results also demonstrate that increased sanitation efforts reduce the vector population, early detection shortens the duration of infectiousness, and hospitalization decreases both complications and the likelihood of further spread. The sensitivity analysis is conducted on the reproduction number to determine the parameters that most strongly influence disease transmission [2]. The findings indicate that factors such as mosquito biting rate, vector recruitment, and transmission probabilities tend to increase disease spread, while improved sanitation, faster detection of infected individuals, and effective hospitalization contribute significantly to reducing transmission. Numerical experiments are performed to support the analytical results and to evaluate the combined impact of the control measures [3]. The simulations suggest that a coordinated application of sanitation, early detection, and hospitalization can substantially reduce infection levels, potentially leading to effective control of dengue fever.

***K*eywords** Dengue fever · Sanitation · Detection · Stability · Reproduction number · Sensitivity

References

[1] Ndii, M.(2022) The effects of vaccination, vector controls and media on dengue transmission dynamics with a seasonally varying mosquito population. *ResultsPhys.*, 34,105298. https://doi.org/10.1016/j.rinp.2022.105298 (2022).

[2] Pandey, H. R., Phaijoo, G. R. and Gurung, D. B. (2023) Analysis of dengue infection transmission dynamics in Nepal using fractional order mathematical modeling. *Chaos Solitons Fractals*, 11, 100098. https://doi.org/10.1016/j.csfx.2023.100098.

[3] Agarwal, P., Singh, R. and Rehman, A. (2021) Numerical solution of hybrid mathematical model of dengue transmission with relapse and memory via Adam-Bashforth-Moulton predictor-corrector scheme. *Numerical solution of hybrid mathematical model of dengue transmission with relapse and memory via Adam-Bashforth-Moulton predictor-corrector scheme.*, 143, 110564. https://doi.org/10.1016/j.chaos.2020.110564

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