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Dynamics and optimal control of a non-linear epidemic model with relapse and cure

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## Highlights:

- We introduce the basic reproduction number for a general epidemic model with graded cure, relapse and nonlinear incidence rate in non-constant population size.
- We established that the disease free-equilibrium state  $E_f$  is globally asymptotically exponentially stable if  $R_0 < 1$  and globally asymptotically stable if  $R_0 = 1$ .
- We showed the globally asymptotically stable of  $E_e$  under the condition  $R_0 > 1$ .
- We consider two types of control to reduce the number of infective individuals.
- We solved numerically the optimal control problem.

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