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DYNAMICAL ANALYSIS OF DIPHTHERIA AND PERTUSIS CO-INFECTION WITH OPTIMAL CONTROL

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ABSTRACT
Diphtheria and Pertussis are vaccine-preventable respiratory diseases which pose as public health challenge particularly in infants and children who missed out of routine vaccination programs during Covid-19 outbreak.
This study hinges on the fact that pathogens can coexist in a host, therefore we propose a non-optimal and optimal control intervention strategy to check the transmission co-dynamics of diphtheria and pertussis. The SIR-type model was utilized and modified into 8 compartments with Vaccination at birth, Maternal derived immunity and partial quarantine as non-optimal control disease controller. The study established that the model is both epidemiologically and mathematically sound.
The next generation matrix was used to derive the co-infection of the basic reproduction number of the co-infection, after which stability analysis was done. The formulated model exhibits four equilibria points, which are; diphtheria-free equilibrium, pertussis-free equilibrium, co-infection-free equilibrium and co-infection endemic equilibrium. The sensitivity analysis was manually calculated to know the effects and magnitude of each parameter on the basic reproduction number.
Furthermore, the existence of an optimal control was established, The Hamilton and Pontryagin principles for optimal control was employed to provide insights on control input interventions such as disease awareness campaigns, vaccination programs, provision of personal protective equipment (PPE) for health workers, cocooning and intensified diagnosis efforts. The accuracy of the pertussis-diphtheria co-infection model was validated through theoretical and Numerical simulation and relevant results are graphically displayed.

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