منشورات جامعة وادي النيل
مجلة النيل للآداب والعلوم الانسانية
(ISSN: 1858 – 7054)
المجلد السادس، العدد الأول ،2025م
nilevalley.edu.sd

"Mathematical Optimization of Cholera Vaccination: Applying Pontryagin's Maximum Principle to SIR-B Modeling in South Sudan's 2006-2007"

Magdoleen Abdelghani[1] , ,Eihab Bashier[2] , Mohammed Bakheet[3]

1,3 Faculty of Mathmatical Sciences and Statistics, Alnelain University, Khartoum, Sudan.

2 Faculty of Education and Arts, Sohar University, Sohar, Oman, Faculty of Mathematical Sciences,

University of Khartoum, Khartoum, Sudan.

Corresponding author: magdoleenabdelghani@gmail.com

Abstract

This study aims to develop optimal vaccination strategies to control cholera outbreaks in resource-limited settings such as South Sudan, where conventional models struggle to balance epidemiologic efficacy and economic feasibility. By applying optimal control techniques (Pontryagin's maximum principle) to the extended SIR-B model and using advanced numerical algorithms to analyze the 2006-2007 outbreak data, the study aims to achieve three main objectives: First, to design effective vaccination strategies capable of significantly reducing the number of infected individuals; second, to minimize operational costs while maintaining efficiency; and third, to optimize the allocation of limited resources. The results showed that this methodology is capable of radically modifying epidemiological behavior, as the numerical simulation led to a significant reduction in prevalence rates and an improvement in public health indicators, confirming the applicability of this model as an effective tool to support health decisions in the face of epidemics, with the possibility of generalizing it to other diseases in the future.

Keywords: *South Sudan, Cholera model, Pontryagin's Maximum Principle, Basic reproduction.*

.