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RSV Seasonal Outbreak Projections in Alberta: A Mathematical Modeling Study

Respiratory Syncytial Virus (RSV) has become a significant global concern, causing respiratory illness in infants, children, older adults, and immunocompromised individuals. According to the WHO, RSV causes 3.6 million hospitalizations and 100,000 deaths annually worldwide in children under five. My research aim is to develop a mathematical model to analyze the transmission dynamics of RSV. This study also aims to assess whether mathematical models can accurately predict RSV's epidemic peak magnitude, peak duration, peak timing and intensity. A five-age group mathematical model, based on the standard SIR framework, was developed to capture the complex transmission dynamics of RSV, incorporating heterogeneous contacts across the entire population. The model is calibrated using Bayesian inference and Diffusive Nested Sampling in MATLAB. Key challenges include nonidentifiability and computational complexity arising from a higher-dimensional system of equations and parameters. We used advanced calibration algorithms with multiple data sets and informed parameter priors to address challenges. RSV case counts for Alberta in the 2024–2025 season are projected using the model and validated against real-time data to enhance accuracy and reliability. The model projects a peak week magnitude of 568 RSV cases, closely matching the confirmed case count of 562. The model accurately captured the rise to the peak, with the peak week occurring within the predicted range. Projections from the model provide essential recommendations for health authorities to prepare for RSV outbreaks and guide targeted prevention and management efforts, strengthening public health resilience and informing policies to reduce the RSV burden.