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Preventing HPV-Induced Cervical Cancer in Alberta, Canada: A Mathematical Modelling study

Human Papillomavirus (HPV) is a widespread sexually transmitted disease responsible for nearly 99.7% cervical cancer. Despite extensive public health efforts, controlling HPV transmission remains challenging, and our objective was to explore factors contributing to the gap in achieving widespread prevention. This research used mathematical model to explore HPV infection and vaccination in Alberta, aiming to identify an effective program to reduce HPV-associated cervical cancer burden. We developed an age and sex stratified compartmental model based on the SIR framework, calibrated using Bayesian inference and Diffusive Nested Sampling in MATLAB. A key challenge was limited availability of male data due to minimal testing, lower awareness, and existing models under emphasizing men's role in HPV transmission, despite their significant contribution to the spread of the virus. By incorporating complex contact patterns and disease characteristics, the model assessed various vaccination scenarios and provided insights into long-term health outcomes, estimating reduction in cervical cancer incidence and quantifying the strategy's effectiveness. Our analysis revealed, implementing vaccination strategy with 90% coverage for individuals aged less than 20 and 40% coverage who aged 20+, across males and females, resulted in significant long-term benefits. Specifically, this approach led to 77% reduction in HPV prevalence among females aged 20+ and a 76% decrease in cervical cancer incidence over 52 years. These findings highlight the transformative potential of targeted vaccination strategies in reducing HPV cervical cancer, alleviating the disease burden, and saving lives. Such strategies can inform policy, raise awareness, and drive higher vaccination coverage for long-term public health benefits.