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Using random networks to study the dynamics of respiratory syncytial virus (RSV) in the Spanish region of Valencia

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ABSTRACT

Seasonal fluctuations in the incidence of several respiratory infections are a feature of epidemiological surveys all around the world. This phenomenon is characteristic of influenza and respiratory syncytial virus pandemics. However, the explanation of the seasonal outbreaks of these diseases remains poorly understood. Many statistical studies have been carried out in order to provide a correlation of the outbreaks with climatic or social factors without achieving a definitive conclusion. Here we show that, in a random social network, self-sustained seasonal epidemics emerge as a process modulated by the infection probability and the immunity period after recovering from the infection. This is a purely endogenous phenomenon that does not require any exogenous forcing. Assuming that this is the dominant mechanism for seasonal epidemics, many implications for public health policies for infectious respiratory diseases could be drawn.

1. Introduction

Respiratory syncytial virus (RSV) is a single-stranded RNA virus discovered more than 50 years ago in a child with bronchiolitis [1]. This virus is the cause of a seasonal epidemic in many countries all around the world. In Spain alone, there are around 15,000–20,000 visits to primary care units due to RSV every year. Also, up to 18% of the pneumonia hospitalizations of people older than 65 are due to RSV [1]. This epidemic is also a major concern for immunocompromised patients at any age [2].

Its coincidence with other seasonal epidemics, such as influenza and rotavirus, produces a large number of hospitalizations each year, and saturates the National Health System. In particular, the cost of pediatric hospitalization for the Valencian Health System has been estimated as 3.5 million euro per year [3] without taking into account indirect costs [4], with a cohort of newborns of 45,000 children.

The main characteristic of RSV and influenza pandemics is its seasonality, i.e., its incidence on the human population fluctuates broadly and regularly each year, with large peaks of infections occurring at the same time of the year in the same country. However, depending on the country, the time at which the largest peak is reached varies from midwinter to early spring [5]. Seasonality is also found in climatic conditions as different as those of The Gambia, Singapore, Florida or Finland [6]. In the case of tropical countries, a connection with the rainy season has been suggested. Following the idea of the influence of climatic conditions, whatever they might be, on the infection probability, the seasonal behavior is forced into standard models by proposing a cosine variation in the form $b = b_0 + b_1 \cos(2\pi t)$, where t is measured in years.

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