Examining the influence of weather on rotavirus infection

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Determining the influence of climatic factors on infectious diseases can be complex and beset by technical and epidemiological problems, although there is value in establishing the contribution of the environment in general, and weather in particular, to disease occurrence in order to prepare for future alterations in climate.

The cohort study of rotavirus infection by Josh Colston and colleagues[1] in *The Lancet Planetary Health* used data from eight study sites to examine the effects of hydrometeorological variables on the occurrence of rotavirus infection in symptomatic and asymptomatic children younger than 2 years. This study involved 2100 participants (asymptomatic and symptomatic children); 42 910 monthly faecal samples were tested for rotavirus infection, as were 7131 samples from children with diarrhoeal symptoms in Bangladesh, Brazil, India, Nepal, Pakistan, Peru, South Africa, and Tanzania. The authors included three locations where the rotavirus vaccine has been used and five where it has not. This study aimed to identify causal pathways by analysing the relative impact of different hydrometeorological variables; for instance, the authors state that a strong association with soil temperature and solar radiation suggests that survival of rotavirus outside the host plays a leading role in the epidemiology of this infectious disease, whereas a strong association with pressure and wind implies aerial dispersal of rotavirus particles.

Rotavirus is a highly contagious non-enveloped double-stranded RNA (dsRNA) virus with a complex architecture of three concentric capsids and is primarily transmitted from person to person in children.[2] Rotavirus infection is common in newborn babies and tends to be mild or asymptomatic as a result of protection from maternal antibodies. Rotavirus is a vaccine-preventable disease, with administration of the first of two doses between 6 weeks and 14 weeks of age.[3] Vaccine administration can reduce the occurrence of hospital admissions, symptomatic disease, and deaths,[4] and particularly reduce the frequency of deaths in developing countries.[5]

Rotavirus is a seasonal infection in developed western countries, with an annual peak in late winter.[6] The seasonal reduction in rotavirus cases following the introduction of childhood vaccination is marked,[7,8] and changes in seasonality with vaccination can lead to a peak every 2 years rather than annually. In developing equatorial countries rotavirus has been less seasonal than in developed western countries.[2] The effectiveness of vaccination depends on vaccine coverage, which can vary by socioeconomic factors.[4] Seasonal occurrence might commonly be associated with some hydrometeorological variables (eg, colder temperature in winters when rotavirus infection is most common), many of which might be correlated. If weather is a causal element of the disease, such studies ideally need to show that normal disease incidence throughout the year (ie, its seasonality) is in some way linked to weather, that seasonality at different sites is not related to differences in behaviour, that an association with weather is not merely a collinearity that reflects some other seasonal contribution, that a comparison across geographical regions reflects the same transmission routes, and that the model representing all the sites is justified by the results. The epidemiology of transmission should be similar across all sites, and will be influenced by the survivability of the virus outside the host, dispersal of the virus through the environment, and host factors and behaviours.

Because rotavirus occurrence in developed countries is strongly seasonal, the weather associations have been modelled by a distributed lag non-linear regression model[9] and an SIRS-based partly observed Markov process model.[10] An association with temperature has been reported since the early 1980s. The study by Colston and colleagues[1] found that only a low proportion (3·4%) of the variability explained by the final absolute effect interaction model could be explained by environmental variables. This finding suggests that the driver of the annual cycle of rotavirus infection is the constant birth of new susceptible babies, and that the occurrence of the peak in late winter might reflect the stabilisation of a cycle through greater transmission potential at this time, possibly as a result of longer survival of the virus when being transmitted from person to person.

Human-to-human transmission was not explicitly included in the model, although some of its aspects are likely to be incorporated in the host factors analysis. Furthermore, the Fourier and spline terms in the model might capture the potential peaks and other non-periodic signals (eg, variation in the total population and therefore in the pool of susceptible individuals) arising from the dynamics of human-to-human transmission. We believe that the type of approach used in this work could be successfully complemented by integrating it with a mechanistic model for human-to-human transmission to tease apart the impact of extrinsic environmental drivers from intrinsic non-linear dynamics resulting from feedbacks within the system, due to, for instance, changes in the level of immunity in the host population and variation in susceptible individuals.[11] Explicit inclusion of human-to-human transmission and depletion of susceptible individuals in a Poisson-like model could be done, for instance, by allowing memory of a past event in the rate of change.[12]

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