Is COVID-19 seasonal?

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COVID-19 Actuaries Response Group – Learn. Share. Educate. Influence.

Summary

Common coronaviruses, like influenza viruses, are highly seasonal diseases, with cases peaking in winter months. As we move out of lockdown and through the summer months in the Northern hemisphere, an obvious question is whether COVID-19 exhibits seasonality, as this will have a direct impact on the timing and level of any second wave of infection.

This bulletin considers the factors typically involved in seasonality of diseases, and the research on the likely seasonality of COVID-19. Whilst direct evidence is limited, based on our overview of the research and the data available, we do expect the virus, SARS-CoV-2, to show some seasonality in transmission in the UK and other countries.

It is worth noting that it is difficult to make a strong assertion on this as lockdown will have significantly reduced the number of cases which would otherwise have been experienced in many countries. A further (directly season-related) complication is that Southern hemisphere countries are now in their influenza season. This means that they are finding it difficult to definitively allocate cases of (and deaths from) respiratory diseases to COVID-19 or other seasonal respiratory diseases.

Introduction

Because SARS-CoV-2 is a new virus, there is no direct evidence of seasonality within an individual country. It is also likely that, with a novel pathogen, typical seasonal patterns of infectivity will be masked because no individuals have been exposed in the past, and possibly also by the evolutionary path of the virus over the early phase of its transmission in humans.

We can make some tentative inferences on the likely drivers of seasonality of SARS-CoV-2 based on the behaviour of other viruses. We can also look at how the outbreak has manifested itself in countries with different climates.

Drivers of seasonality

Influenza transmission has been found to be enhanced by cold and / or dry air (link), and increases in risk of SARS is linked to sharp changes in temperature (link).

The transmission method of SARS-Cov-2 (predominantly via respiratory droplets and aerosols) is also indicative of likely seasonality, because it is harder for viruses transmitted in this way to spread in more humid conditions. Again, an inverse relationship between infection and relative humidity has been seen in studies of other coronaviruses (SARS and MERS). Studies have also shown that the survival time of coronaviruses on surfaces depends on temperature, suggesting that this may be a factor in disease transmission.

Whilst there have been a number of studies carried out on the impact of seasonal factors such as temperature and humidity on the COVID-19 outbreak; most are based on experience from early in the outbreak and hence have relatively little data. Alongside these studies, we can also look at the spread of the COVID-19 outbreak across countries with different climates

One such study (link) found that 83% of testing and 90% of cases had been conducted in non-tropical countries, meaning that a simplistic reading of the statistics relating to temperature and humidity could be misleading. However, even at an early stage, several countries between 30°N and 30°S (including Australia, Singapore and Japan) had carried out extensive testing. Because positive COVID-19 tests were lower per capita in these countries, the role of climate and seasonality should be considered.

Temperature

A study of COVID-19 transmission in Chinese cities in January to March (link) found no association with either temperature or UV radiation. This study estimated the basic reproduction number (R_0) for 62 cities, 50 outside Hubei and 12 inside. The authors hypothesised that warmer seasons were likely to lead to lower reproduction numbers, but the data did not support this – the paper also cited a similar outcome from analysis of the MERS epidemic.

A study analysing 749 locally acquired cases during the early epidemic phase in New South Wales, Australia (link) also found no link between temperature and increased numbers of cases. This study also included analysis of the impact of humidity which is summarised in the next section of this bulletin.

On the other hand, a study (link) of transmission in Brazil, again early in the epidemic (February 27 to 1 April) showed that transmission was at its lowest for temperatures below 25.8°C, with each 1 degree rise in temperature up to 25.8°C being associated with around a 5% decrease in the number of confirmed cases of COVID-19.

A third study (link), using data up to 10 March, compared 8 cities with significant COVID-19 spread with 42 cities which either had not been affected or did not have substantial community spread. The study found that the most affected cities were located within a narrow geographic band (broadly 30°N to 50°N) and that they had similar mean temperatures (between 5°C and 11°C). This study suggested that, based on climatic conditions in March and April, community spread was likely to affect areas north of the existing areas at risk. In particular, Eastern and Central Europe, the UK, the Northeastern and Midwestern United States were areas mentioned as being at risk during March and April.

In addition, recent clusters of reported cases of COVID-19 in meat packing facilities in Germany and the United States are also indicative that temperature and humidity are likely to be factors in the spread of COVID-19 - the environment in these facilities is cold and humid; with people working very close together.

Humidity

Humidity is a measure of the amount of water vapour in the air. Typically, warmer air can carry more water vapour than cooler air, given a significant amount of available water.

Relative humidity is the most common measure used, measuring how close the air is to being saturated. If relative humidity is at 100%, then no more water vapour could be contained in the air at that temperature.

The physiology behind relative humidity and infection is not fully understood or proven, but it is hypothesised that we may be less able to clear our airways of trapped pathogens at lower relative humidity, whilst there may be more aerosolised virus at higher humidity, and hence more exposure opportunity.

The Australian study noted above suggests that lower relative humidity (but not rainfall and temperature) was associated with increased numbers of cases, with a 1% reduction in relative humidity being associated with an increase of 6% in COVID-19 cases. It is worth pointing out that this study was carried out under the conditions of higher temperatures in the southern hemisphere summer.

This review (link) gives a slightly different view, setting out that transmission could be lowest between relative humidity levels of 40% and 60%. In addition, the third study noted in the temperature section above found that, as well as having similar temperatures, the worst affected cities had similar levels of absolute humidity.

In the UK, the winter months typically have the highest relative humidity – in the summer, humidity is lower but not sufficient to mean that our ability to clear our airways is inhibited.

Biological / behavioural aspects

Human behaviour differs significantly by season – in summer months, people tend to spend more time outside. This can lead to higher concentration of vitamin D (which may be associated with lower susceptibility to infection). It also means that individuals are naturally more socially distanced (on average) than in winter months when people tend to be indoors and often in poorly-ventilated public spaces. People also tend to have higher physical activity in spring and summer compared to winter.

The human immune system also appears to experience seasonality, with higher vulnerability to infection in winter months. It has been suggested that this is either due to vitamin D or seasonality of melatonin production.

Overall, these factors are likely to mean that many viruses (including, presumably, SARS-CoV-2) are less likely to spread as quickly in summer than winter months.

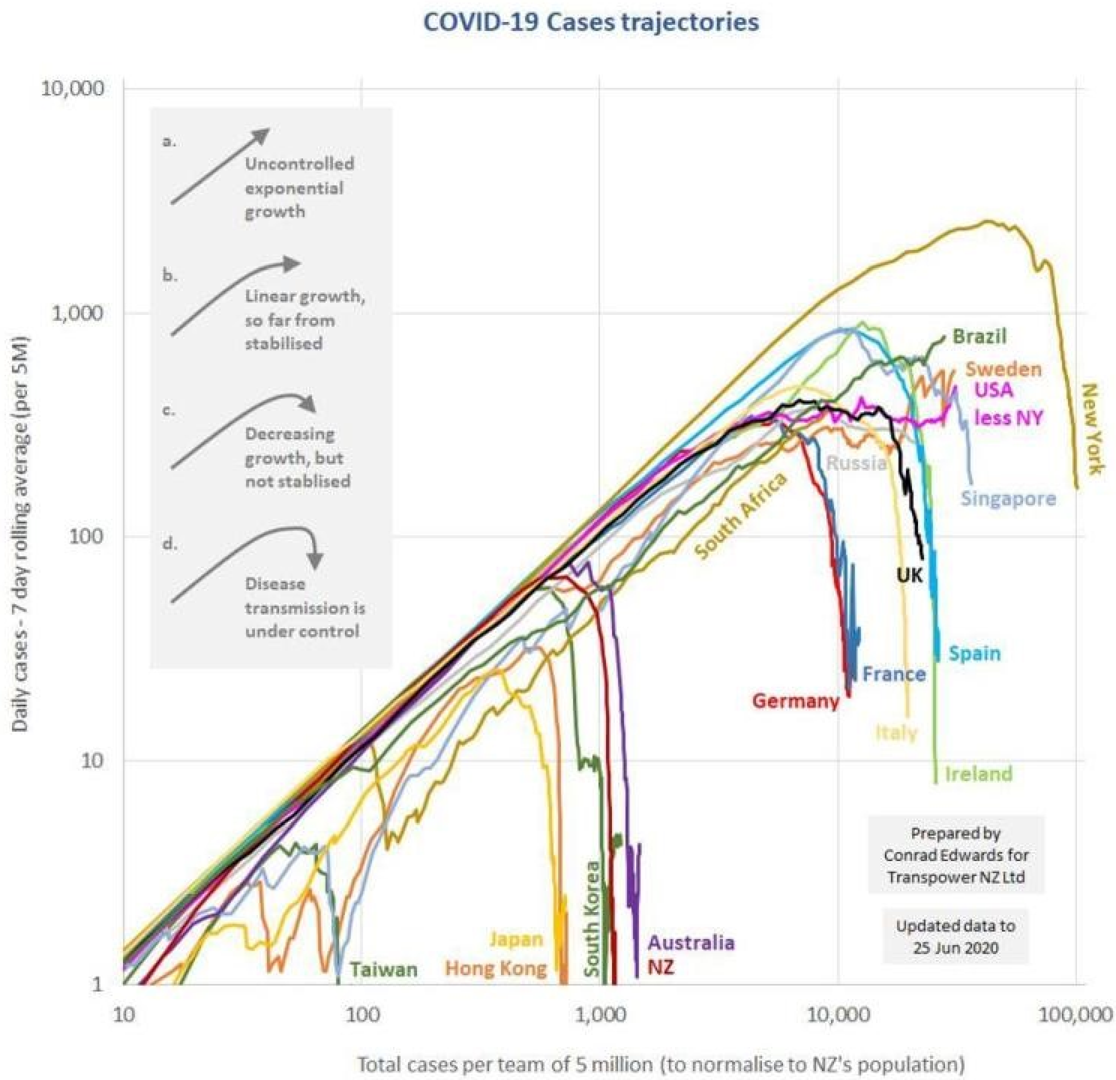
International comparisons

In the temperate regions of the northern and southern hemispheres, influenza transmission is at its highest in winter months - typically peaking in December / January in the Northern hemisphere, and August in the Southern hemisphere. (As an aside, Australia has seen fewer cases of flu in 2020 than in previous years, apparently due to fewer travellers from the Northern hemisphere bringing in infections, combined with social distancing measures.)

The pattern in tropical and subtropical countries is somewhat more complex. Research suggests that most of South America plus South Africa, India and much of Asia, have a primary season in April to June. Central African countries typically have primary seasons in July to September or October to December, and Northern African countries in October to December or January to March (link 1 / link 2).

Looking at the spread of COVID-19 across the world (for example via the charts produced by Conrad Edwards which we have previously presented (link, and shown below)), whilst the outbreak in Europe was significantly later than a typical flu season, the fact that recent significant outbreaks have been in Southern hemisphere and tropical countries (see for example Brazil, Singapore and South Africa) appears to align well with what might be expected from a seasonal virus.

It is of course very difficult to draw strong conclusions from this observation, particularly given the likely impact of social distancing and lockdown on outbreaks in the various different countries.



Conclusion

As we set out above, studies that have looked to investigate the impact of seasonal factors on the transmission of SARS-CoV-2 have not shown consistent results; however, the pattern of cases and deaths in countries with different climates does appear to be indicative of seasonality in disease transmission.

For Northern hemisphere countries, seasonality is likely to mean that infections will remain at a relatively low level over the summer months, despite the easing of social distancing and other non-pharmaceutical interventions (NPIs). However, if it does not prove possible to keep the number of infections to a very low level, we would expect to see a second wave of infection in the winter months, which is likely to need to be mitigated (via test, track and trace if this is feasible, or by re-applying some NPIs), and to lead to further deaths.

Alternatively stated, whilst a low level of circulating SARS-CoV-2 in the UK during the summer will be welcome, it should not be assumed that higher numbers of cases will not return later in the year. It is also important to note that a seasonal resurgence in SARS-CoV-2 and subsequent COVID-19 diagnoses would coincide with the influenza season, meaning that hospital and other medical resources may be stretched. Of course, only time will provide us with the bigger picture.

8 July 2020

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