Australian Government

Chief Scientist

15 April 2020

The Hon Greg Hunt MP
Minister for Health
Parliament House
CANBERRA ACT 2600

CC:
The Hon Karen Andrews MP, Minister for Industry, Science and Technology
Dr Brendan Murphy, Chief Medical Officer

Dear Minister

Please find attached a response to your request for advice on the impact of winter on the spread of COVID-19, which has been prepared by the Rapid Research Information Forum that I Chair. This rapid report synthesises the evidence base on this matter and has been informed by relevant experts and has been peer reviewed. Details of the authors and peer reviewers can be found in the Appendix.

Human behaviour is a dominant contributor to the transmission of COVID-19 and physical distancing will have a more potent impact on controlling the spread than seasonal variability. It appears that in Australia, public policy will play a more dominant role than the arrival of winter on the viability and virulence of the SARS-CoV-2 virus.

I hope this document proves useful to you and your colleagues.

Yours sincerely,

Dr Alan Finkel AO FAA FTSE FAHMS
Australia's Chief Scientist

GPO Box 2013
Canberra ACT 2601
Australia

Telephone: +61 2 6102 9210
Facsimile: +61 2 6213 6558

Email: chief.scientist@chiefscientist.gov.au
Web: www.chiefscientist.gov.au

Rapid Research Information Forum – Seasonality of COVID-19: Impact on the spread and severity

15 April 2020

- Notwithstanding the recent emergence of SARS-CoV-2, research suggests there will be some influence of winter on spread and severity.
- Lower humidity and air temperature can increase the viability and virulence of the virus and therefore its infectivity.
- Physical distancing supported by effective public policy measures will have a greater impact on managing the spread of SARS-CoV-2 than seasonal climate.
- The concurrence of COVID-19 with other viruses during winter, such as influenza, will likely exacerbate demands on health services, especially for vulnerable people and communities.
- The onset of winter may further exacerbate the psychological effects of COVID-19, especially if quarantining measures are extended.

This rapid research brief responds to the request for advice on how winter may impact on the spread and severity of the SARS-CoV-2 virus, which causes the disease COVID-19.

The COVID-19 pandemic began in Wuhan, China during the Northern Hemisphere's winter season. The virus rapidly spread around the globe and Australia's first case was reported in the middle of the Southern Hemisphere's summer.[1] While some influenza viruses exhibit characteristics of seasonality, it is still too early to make definitive judgements about whether this pattern will hold for SARS-CoV-2 in general, and within Australia specifically. The key unknowns include: how the viability and spread of the virus are affected by climate, how the effect of rising immunity within the community will impact the spread, and the degree to which social isolation can mitigate the seasonal effects. Against this backdrop, as Australia moves into winter, the question arises as to how the change in seasons will impact our efforts to 'flatten the curve'.

With the arrival of winter in Australia, it is possible to address the potential increase in the spread of SARS-CoV-2 with adequate public policy measures that rely on broad compliance. Human behaviour appears to be the dominant contributor to the transmission of COVID-19,[2] and physical distancing will have a more potent impact on controlling the spread[3] than seasonal variability. In Australia, public policy will play a more dominant role than the arrival of winter on the viability and virulence of SARS-CoV-2.

Effects of climate on SARS-CoV-2

Viral respiratory infections generally worsen in winter because lower air temperature and humidity increase both the survival of viruses and viability of aerosols and droplets – which spread the viral particles through the air. Current evidence demonstrates that SARS-CoV-2 is primarily transmitted via respiratory droplets, although aerosol transmission may also be possible.[4]

Dowell and Ho, from the International Emerging Infections Program, suggest that other human coronaviruses show a seasonal trend in their transmission and infection.[5] With SARS-CoV-2, a similar trend in

relation to temperature and absolute humidity on the viability and virulence of the virus is suggested by the following studies. At the University of Maryland's Institute of Virology, Sajidi *et al.* observe that SARS-CoV-2 transmission has predominantly occurred in global zones that have lower temperatures (5°C to 11°C) and low relative humidity (47% to 70%).[6] Supporting this, Wang *et al.,* from Beihang University, conclude that high temperatures and high humidity reduce the transmission of SARS-CoV-2.[7] This is also consistent with the transmission of the influenza virus. Wang *et al.* suggest that this is due to the viruses' increased stability at lower temperatures, as well as the increased stability of airborne respiratory droplets remaining in low humidity environments. Notably, a drop in absolute humidity has preceded several influenza epidemics in the USA.[8,9]

Qualifying this general trend, Luo *et al.,* from Harvard Medical School, investigated the numbers of COVID-19 cases across China and several other countries with varying climates. The authors observe that changes in climate alone do not directly correlate with the number of SARS-CoV-2 transmissions.[10] Bukhari and Jameel, at the Massachusetts Institute of Technology, conclude that an increase in humidity may be more important than an increase in temperature in slowing the transmission of SARS-CoV-2.[11] And when Oliveiros *et al.*, in Portugal, studied the correlation between virus doubling time and meteorological variables, they found that temperature and humidity could only explain 18% of the variation in disease doubling. Hence other variables such as public health policies and population density must be considered when predicting the transmission and containment of SARS-CoV-2.[12]

Although there is no compelling data that clearly demonstrates a link between winter and increased occurrence of COVID-19, collectively these studies suggest that we may expect an increase in virus transmission in the winter because of cooler, less humid climate. Nevertheless, climate may be a less important factor for SARS-CoV-2 transmission than active containment measures and human behaviour, such as good hygiene and physical distancing. It is essential that Australia continues to monitor new studies as the COVID-19 pandemic unfolds in both hemispheres.

Effects of seasonal factors other than climate

While many respiratory viruses have clearly demonstrated seasonality,[5,13–16] the new SARS-CoV-2 virus has not been around long enough to reveal seasonal patterns.

Neher *et al.,* from the University of Basel, show that seasonal variation in virus transmission is a consistent feature among endemic coronaviruses that affect humans.[17] Using these data, they modelled the implications of seasonality for SARS-CoV-2 and predict a larger peak during the coming 2020–21 winter in temperate regions of the Northern Hemisphere, compared to early 2020. While the study authors note that uncertainty in the parameters is large (e.g. variation in transmission and migration), their advice is that this should not preclude attempts to factor in winter in the monitoring and control of COVID-19 spread.

Although a large number of cases have already been reported in a range of climatic conditions,[11] caution must be exercised in extrapolating these outcomes to Australia. The Australian climate is highly diverse and its winters are not directly comparable to those in the Northern Hemisphere. Changes in population behaviour and physiology throughout the seasons may also contribute to a virus's apparent seasonality. Reduced ultraviolet B (UVB) light during winter can lead to lower vitamin D, which may impair the body's innate immune defences,[18–21] and cold dry air increases the likelihood of respiratory epithelia damage, increases mucus production and impairs innate immunity. [22–24] These factors impair the body's ability to clear pathogens[25] and may make individuals more susceptible to respiratory infection.[26] Increased global connectivity and large indoor gatherings are well known to increase the transmission of respiratory infections via droplet and aerosol spread.[27]

On the other hand, SARS-CoV-2 has demonstrably spread in countries that do not experience winter and therefore it is not a 'necessary' condition. Singapore is one such example.[28] In Australia, where transmission has occurred during summer and autumn, nearly 35% of cases have occurred as a result of local transmission.[29] Local transmissions have been reported in countries with varying climates.[29–32]

Lowen and Palese, from the Mount Sinai School of Medicine, predict the transmission of influenza virus via contact transmission is the major form of virus spread in warmer climates. Contact transmission can be direct, between an infected person and a susceptible person, or indirect, where there is no human-to-human contact but the pathogen is transmitted through contaminated objects or vectors such as mosquitos. Aerosol transmission predominates in temperate climates.[33] Although respiratory droplet and aerosol stability and viral virulence are increased during cooler seasons, with adequate physical distancing measures in Australia and the population's relative low-density housing, impeding the spread of SARS-CoV-2 during winter is achievable.

Intersection of the Australian winter, COVID-19 and other diseases

It is important to consider the increased likelihood of co-infection with other respiratory pathogens during winter, including influenza, which may increase morbidity and mortality. The seasonality of influenza and respiratory syncytial virus (RSV) have been well reviewed.[27]

In addition to the direct consequences of COVID-19, the approach of winter and potential for co-infection could exacerbate demands on our social and health services. Inequities within society can result in individuals from high risk groups (e.g. low socio-economic status, living with disability, remote communities, Aboriginal and Torres Strait Islander communities and socially marginalised) having poorer access to quality health and social services. Winter will involve increased risks and impacts for vulnerable people and communities with respect to COVID-19. Incidences of serious forms of influenza indicate that Aboriginal and Torres Strait Islander people are more likely to become infected and have more serious disease when they

do.[34,35] In many remote Aboriginal and Torres Strait Islander communities, the cooler nights of the dry season may worsen overcrowding as people are unable to sleep outdoors, making physical distancing more difficult.[36] The living circumstances of vulnerable populations is a more important factor than climate related factors in influencing transmission.

Widespread flu vaccination can alleviate the onset and impact of seasonal flu and thereby reduce the demands on our health services, as demonstrated by Japan.[37] Japan has reported a significant decrease in seasonal influenza activity in 2020, which coincided with the COVID-19 pandemic. This has been attributed to vaccination, physical distancing and other COVID-19 prevention measures.[38,39] There are some concerns about the possible concurrence of a respiratory virus, such as influenza, spreading with COVID-19. Such cases may cause mixed infection patterns and increase the impact.[40,41]

Consideration must also be given to the impact of the winter season on potential negative psychological effects of extended quarantine on mental health, for example symptoms of post-traumatic stress disorder.[42] While voluntary quarantine has been associated with lower levels of distress and fewer long-term health impacts,[43] the onset of winter can exacerbate the psychological effects of COVID-19 as individuals are less likely to participate in exercise and physical activity that are known preventative measures for depression and anxiety.[44–46] Suicide risk has increased in prior economic recessions.[47,48] There are concerns regarding the secondary psychological effects resulting from prolonged physical distancing during the COVID-19 pandemic.[49–52]

An important note on available COVID-19 research

Although current COVID-19 research is available through pre-print servers, many of these articles have not yet been peer-reviewed (an imperative pillar of the scientific method) and the relatively short time length of the current outbreak has resulted in variable testing and reporting practices in different countries. As such, conclusions drawn need to be interpreted with caution.

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APPENDIX

Authors and peer-reviewers of this rapid research report

Authors:

Professor Allen Cheng, Monash University

Professor Helen Christensen AO FASSA FAHMS, Director and Chief Scientists, Black Dog Institute

Professor Tony Cunningham AO FAHMS, Westmead Institute for Medical Research, University of Sydney

Professor Andrew Cuthbertson AO FTSE FAHMS, Chief Scientist, CSL Limited

Dr Trevor Drew, Director Australian Centre for Disease Preparedness, CSIRO

Professor Sharon Friel FASSA, Australian National University

Professor Fiona Stanley AC FAA FASSA FAHMS, University of Western Australia

Professor Carola Vinuesa FAA, Australian National University

Peer reviewers

Professor Warwick Anderson AM FAHA FASSA FAHMS, University of Sydney

Professor Alex Brown FAHMS, South Australian Health and Medical Research Institute

Professor Emma Kowal FASSA, Deakin University

Professor John Shine AC PresAA, President, Australian Academy of Science

The production of this rapid research report was supported by staff of the Australian Academy of Science: Dr Jana Phan, Mr Daniel Bouzo, and Mr Chris Anderson.

RAPID RESEARCH INFORMATION FORUM

SEASONALITY OF COVID-19: IMPACT ON THE SPREAD AND SEVERITY

The Rapid Research Information Forum (RRIF), convened by Australia's Chief Scientist, Dr Alan Finkel AO, is a forum for rapid information sharing and collaboration within the Australian research and innovation sector. It provides a mechanism to rapidly bring together relevant multidisciplinary expertise to address pressing questions about Australia's response to COVID-19, as they emerge. RRIF enables timely responses to be provided to governments based on the best available evidence. RRIF also informs the Chief Scientist's interactions and collaboration with other national chief scientific advisers. RRIF demonstrates the critical value of research and innovation in driving societal as well as economic progress now and into the future.

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- Australian Academy of Technology and Engineering
- Academy of the Social Sciences in Australia
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- Royal Society Te Apārangi (New Zealand)
- ACOLA
- State and Territory Chief Scientists
- Chief Science Advisor to the Government of New Zealand
- Scientific expert members of the National Science and Technology Council
- CSIRO
- Universities Australia
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