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Environmental factors and their role in the transmission of SARS-CoV-2

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ABSTRACT

In December of 2019, several cases of atypical pneumonia caused by an unknown agent were reported in Wuhan, the capital city of Hubei Province in China. In early January 2020, it was announced that these cases were caused by a novel coronavirus. The virus was later named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), which causes a disease associated with atypical pneumonia termed Corona virus disease 2019 (COVID-19). Several respiratory viruses, including coronaviruses and influenza viruses tend to have prominent peaks of infection during colder seasons, especially in temperate regions. The cold temperatures, along with accompanying dry conditions can drive respiratory tract infections by assisting with viral transmission, weakening the human immune system, and increasing viral molecular stability. Though the topic of SARS-CoV-2 transmission and warm weather has been associated with misinformation campaigns, it is worth investigating since an informative answer may give an indication of the future behavior of SARS-CoV-2.

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1. Introduction

As this is a recently emerging virus, there is continuous progress being made to develop effective vaccines and antivirals to combat this virus. Currently, several highly effective vaccines are being produced internationally. In terms of treatments, the most rapid method is through approved drug repurposing. Various drugs such as remdesivir have been developed for other diseases like Ebola, but studies have also suggested their efficacy against COVID-19 [1]. Recently we also suggested the combinatorial use of repurposing drugs/molecules which target the host and pathogen mechanisms could be considered as an effective strategy to treat COVID-19 [2]. Novel treatments will take time to bring into the clinical sphere since there will be thorough testing to analyze safety in humans. Consequently, nations are resorting to basic public health measures such as social distancing, wearing masks, and quarantines to try and curb the exponential rate of infectivity of the virus. At the present, effective vaccines have been another

critical resource that is being used to curb infection rates and the emergence of variants. Even so, SARS-CoV-2 has taken an immense toll on the international community. Health care workers in specific are at a higher risk of infection during the caring of COVID-19 patients. We have recently reviewed the risk for SARS-CoV-2 infection among health care workers and suggested preventive management during the COVID-19 pandemic [3].

Within the public and media spheres, there has been a stream of misinformation in regards to the effect of warmer weather affecting SARS-CoV-2, especially in the early days of the pandemic. Several viral respiratory infections follow patterns of seasonality where higher rates of incidence occur during the winter time in temperate regions [4]. A seasonal virus is defined as one that tends to prominently circulate during specific months of the year. For example, the peaks of influenza virus infections in the northern hemisphere occur from December to March [5]. Members of the coronavirus family also exhibit patterns of infection based on specified seasons. In temperate climates, common cold coronavirus infections are at low levels throughout the summer and fall months, and infections peak in the winter and spring months [6]. MERS-CoV is another coronavirus, but highly pathogenic causing Middle Eastern Respiratory Syndrome (MERS). It is impossible to imply seasonality of the infection patterns of MERS because it was contained relatively quickly, and sporadic infections afterwards have

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been intermittent without obvious seasonality [7]. SARS-CoV-1, the closest relative to the pandemic causing SARS-CoV-2 virus, was luckily contained quickly making it impossible to assess seasonality.

In terms of SARS-CoV-2, it is assumed to have a similar transmission pattern to the influenza virus [8]. A study was published in November 2020, where the authors investigated the influence of temperature, precipitation, and UV exposure on SARS-CoV-2 transmission. The authors found that a temperature above 52 °F in a given day is associated with a decreased rate of infections for the following five days. This was a similar result when the UV index was greater by one unit, though precipitation was not correlated to any decrease or increase of new cases [9]. This study is limited as it was performed in an overall colder season so future studies will be needed to better characterize the temperature and humidity relationship SARS-CoV-2 transmission. Another initial study suggested a role for environmental factors in SARS-CoV-2 transmission as it was found that there was higher rates of transmission in regions with an average temperature of 5 °C–11 °C, and a range of absolute humidity at 4–7 g/m³ [10]. A different study found that SARS-CoV-2 transmitted with more difficulty in regions with high temperatures and high relative humidity, in comparison to regions with cooler conditions [11]. The understanding of temperature and weather effects on the transmission of SARS-CoV-2 is highly needed in order to infer future infection peaks, as well as to guide effective suggestions on disinfecting procedures in hospitals and commonly touched surfaces. Early studies have shown that in healthcare settings, SARS-CoV-2 is viable on surfaces for hours to even days [12]. The length of viral survival on these surfaces greatly depends on environmental factors such as temperature and relative humidity [13].

2. Factors linked with warm weather vs. COVID-19

There are a few reasons that may help us understand why various “seasonal” virus infections seem to dissipate during the warmer months. One of the most pressing factors of seasonality is based on a sociological understanding. In the colder months, humans spend more time indoors where there is less ventilation and a greater population density, in comparison to the outdoors [14]. The best example of this is schools, which are often hubs for infectious disease transmission. There has been a relatively small number of children diagnosed with COVID-19, but it is unclear whether this is due to children not being infected as easily, or because their infections generally present milder symptoms that tend to go unnoticed, as noted by a study published March 13, 2020, which reported the characteristics of pediatric COVID-19 patients, all of which showed milder symptoms in comparison to infected adults [15]. Serological testing would give us insight into the glooming questions regarding children and COVID-19. Understanding this is the major key to anticipating the rate of transmission happening in schools, and may provide a timeline of when it is safe to send children back to in-person classes.

Another factor of transmission dynamics is dependent on environmental conditions. During the colder months, the air is colder and less humid. Various indications suggest that a lack of humidity allows viral particle suspension for longer periods. For Influenza, research has shown that humidity strongly affects flu transmission dynamics, reporting that less humid conditions are more favorable for the transmissibility of the virus [16]. There is little understanding of the transmission dynamics of SARS-CoV-2, and with minimal literature available with similar respiratory viruses, it’s difficult to determine the effect that this environmental factor will have on SARS-CoV-2, if any at all. There are also suggestions that the overall condition of the immune system is worse in the winter than in the summer, though the claim is controversial as the research findings are unclear [17]. There has been a new investigation on how weather plays a role in

the stability of SARS-CoV-2, and groups have been reported that higher temperatures lead to decreased molecular stability of SARS-CoV-2 [18]. Specifically, due to this pandemic, more research will be needed to investigate the effect of environmental conditions against respiratory viruses.

At the early months of the COVID-19 pandemic, the most common comparison of the novel coronavirus was with the seasonal flu or the common cold. Problematically, this is a comparison of a seasonal pathogen where the pandemic potential is inherently limited. The seasonality of various common cold subtypes (OC43, HKU1, 229E, and NL63) and Influenza’s showcase evolutionary co-existence with its human hosts. Though, it’s important to note, that even relatives of seasonal pathogens can cause pandemics if the strain mutates to an extent where the immune system can no longer identify the intruder as the same pathogen. More so, viruses that are novel to human populations can spread outside of the normal seasonal range in comparison to their longer-established relatives.

3. Conclusion

We have reasons to expect that SARS-CoV-2 will transmit less efficiently during the warmer months, but the accurate mechanism that is responsible for this is not well understood. The infectivity rate of SARS-CoV-2 can be expected to decrease during the summer months, but will not be enough to halt transmission on its own. We may have already seen the effect of environmental conditions on SARS-CoV-2 transmission early in the pandemic where countries in the northern hemisphere with cold climates were more vulnerable to infections, while regions in the southern hemisphere were less effected. In early 2020, a study conducted in China found that the rate of transmission decreased in higher temperatures [19]. During a similar period, a different Chinese group found that though environmental factors may limit SARS-CoV-2 transmission, this alone would not significantly reduce viral transmission without strict implementations of public health interventions [20]. SARS-CoV-2 is a virus that is new to humans, and thus will face fewer immunological obstacles and will consequently transmit more readily outside of the colder months. Seasonality does not constrict novel pandemic potential viruses as it would their older relatives. At this moment, SARS-CoV-2 should not be considered as a seasonal entity. The elucidation of whether SARS-CoV-2 will become seasonal will be contingent on the passage of time, and further studies to understand the effects of environmental factors, such as warm weather, on its transmission. Several experts already suggest that SARS-CoV-2 will become an endemic entity, and there is reason to believe that future infection transmission rates may be effected by seasonality, similar to influenza.

Conflict of interest statement

The authors declare that there are no conflicts of interests.

Author contributions

Dawid Maciorowski: Data Curation, Writing - Original Draft. **Divakar Sharma:** Conceptualization, Writing - Review & Editing. **Adinarayana Kunamneni:** Conceptualization, Writing - Review & Editing.

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