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Review Article

Effect of Sunlight on SARS-CoV-2: Enlightening or Lighting?

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ABSTRACT

In the early stages of the COVID-19 pandemic, many researchers have investigated non-pharmaceutical interventions for restricting the transmission of severe acute respiratory syndrome coronavirus 2 (*SARS-CoV-2*), including sunlight. Regarding the lack of effective medicines for *SARS-CoV-2*, the scientific community works to evaluate the effects of physical features of sunlight such as electromagnetic radiation and thermal energy on viral strains. Sunlight gained a considerable amount of attention, including an infamous mention in the White House. Since then, little has become known about further research on the effect of sunlight on SARS-CoV-2. Existing evidence focuses on germicidal wavelengths of the *Ultraviolet* (*UV*) and the stimulation of vitamin D production. UV radiation types B and C have a high germicidal capacity but are blocked by the atmosphere due to their harmful effect on living species. UV radiation type A, which reaches the surface of the earth, has a quite lower germicidal potential. The contribution of vitamin D in the immune response against COVID-19 is yet to be discussed. With the third spike of the pandemic affecting more and more countries worldwide, understanding the effect of sunlight on COVID-19 can help public health officials to design their action plans. At the same time, shedding light on this matter will contribute to debunking popular myths circulating since the onset of the pandemic and draw a clear line between health literacy and misinformation.

In the early stages of the COVID-19 pandemic, many researchers have investigated non-pharmaceutical interventions for restricting SARS-CoV-2. While effective drugs are not available, the scientific community has tried to assess the effects of physical factors such as sunlight and temperature on virus strains [1]. Sunlight gained a considerable amount of attention, including an infamous mention in the White House. Since then, little is known about further research on the effect of sunlight on SARS-CoV-2. However, evidence regarding the effect of sunlight on SARS-CoV-2 could be of great help for countries with a high UV index, such as New Zealand, Latin America, Mediterranean, and Middle-East countries [1]. At the same time, assessing the pragmatic effect of sunlight on the virus and conveying credible information to the public is necessary to avoid misconceptions.

Mechanistic Effects of Sunlight on Immunity

Sunlight exposure mediates the production of vitamin D, boosting the function of lymphocytes [2], which orchestrates the adaptive immune response against viruses. Previous studies have shown that sunlight exposure can benefit individuals suffering from major respiratory diseases such as tuberculosis [2].

Whether this applies to COVID-19 has been an object of intense research. A study was conducted in Jakarta, the capital city and business center of Indonesia, which receives the longest duration of sunlight (480 minutes/day and an average duration of 218 minutes). The study mentioned above reported that a higher duration of direct exposure to sunlight was associated with an increase in recovered cases of COVID-19. Based on this finding, it has been suggested that exposure to sunlight may be linked to an improved immune response [3].

Furthermore, sunlight has been shown to alleviate symptoms such as shivering, sore throat, loss of taste and smell [4] in patients suffering from influenza and COVID-19 [5]. Digging deeper into these observations, researchers have strived to identify causal correlations of Ultraviolet (UV) light exposure with COVID-19. Vitamin D, with the chemical structure of a *steroid* molecule, has immunomodulatory, anti-inflammatory, anti-fibrotic, and anti-oxidant effects. It derives from calcitriol, capable of inhibiting inflammatory cytokines' (IL-1 alpha, IL-1 beta, TNF-alpha) production and activity [6].

In addition to increasing the production of Vitamin D, sunlight may protect against COVID-19 through the biological effects of radiation. UV light, which is present in sunlight, can be divided into three types based on their wavelengths, including Ultraviolet A (320-400 nm), ultraviolet B (280-320 nm), and ultraviolet C (200-280 nm). The germicidal effect of UV radiation increases in inverse proportion to wavelength. Therefore, UVC (ultraviolet light type C) is most effectively absorbed by viral nucleic acids. However, UVC is a known carcinogen and is absorbed by the ozone layer. Hence, the sunlight that reaches the ground lacks the germicidal spectrum of UVC [7]. Despite this, a study found that UVB (ultra-violet B) rapidly inactivates SARS-CoV-2 on surfaces, particularly on stainless steel objects. In their experiments, they exposed viral strains within simulated saliva to UVB [8]. They reported that 90% of viral strain was inactivated within 6.8 minutes, which was necessary for the simulated saliva to be dried on a surface [8]. Nonetheless, further studies are required to warrant the potential that UVB holds in protecting against SARS-CoV-2. The germicidal effect of UV per wavelength is summarized in Table 1.

Table 1

Computational Analysis of the Germicidal effect of UVA, UVB and UVC in Combination with the Proportion of these Spectra Reaching the Terrestrial Surface

Radiation type	Wavelength	Germicidal effect	Terrestrial UV light
UVA	350 315 nm	Low	95%
UVB	315 280 nm	Intermediate to low	<5%
UVC	280 254 nm	Intermediate to high	<1%
UVC	254 220 nm	High to intermediate	<1%

The Public Health Viewpoint

These findings suggest that fomite transmission (transmission from objects or materials that can carry an infectious agent) can significantly decrease in outdoor environments directly exposed to sunlight [8]. Another study reported that type A and B UV rays, can inactivate inborne coronaviruses, reducing airborne transmission. Nonetheless, these findings cannot be universal as the stability of the virus varies, depending on the viral load in aerosol, the size and infective dose of aerosol particles, as well as the distance and airflow dynamics between infected and uninfected individuals, and the presence of mitigation measures such as personal protective equipment [9].

The reasons mentioned above can potentially explain the discrepancy in COVID-19 severity across various countries. In countries with hotter climate, the rate of COVID-19 is increasing, but the virulence is diminishing; therefore, the mortality rate remains much lower than the infection rate. During summer, the viral transmission was decreased compared to the second wave of the pandemic in Europe after the end of summer.

However, in terms of health literacy, it is pivotal to clarify that these findings are rather hypothetical. Thorough researches are necessary to establish etiological connections and to support relevant practice guidelines. The potential effect of sunlight on SARS-CoV-2 can be beneficial for managing the pandemic in countries with a high UV index. Moreover, it is important to investigate whether these findings can be applied to novel SARS-CoV-2 variants. On the other hand, misconceptions can easily lead many people to over-expose to sunlight, increasing their cancer risk amid the pandemic. Reports from the WHO indicated that many people worldwide believe that exposing themselves to sunlight can protect them from getting infected with SARS-CoV-2 [10]. Unfounded claims about sunlight can also fuel anti-vax or anti-medicine approaches, with a detrimental effect on individual and public health.

Conclusion

All in all, the pandemic offers an opportunity to investigate the impact of sunlight on immunity further. This challenges scientists to assess the clinical significance of such findings and share them rapidly with the public. Sunlight has a twofold potential. It can either enlighten our efforts to contain the infection or strike as lighting on the grounds of health – illiteracy.

Conflict of interest

The authors have completed the ICMJE Unified Competing Interest form (available upon request from the corresponding author) and declare no conflicts of interest.

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