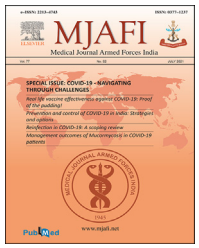
Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/mjafi



Correspondence/Letter to the Editor

Typical environmental factors of high-altitude areas: Possible inactivation mechanisms of severe acute respiratory syndrome coronavirus 2

Dear Editor,

Coronavirus disease 2019 (COVID-19) has caused more than 32 million confirmed cases and more than 988 thousand deaths worldwide as of September 26, 2020. After scientific evidence, on July 9 of the same year, the World Health Organization admitted the possible transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) through the air.[6] Under this new context and considering the environmental and climatic conditions depend on the different geographical areas, high-altitude zones (+2500 m above the sea level) would have three predominant factors that could decrease the spread of the virus:

- Ultraviolet (UV) light: It is a form of electromagnetic radiation with a wavelength between 200 nm and 400 nm. It is suggested that the 200- to 300-nm range could damage the DNA and RNA structure of bacteria and viruses, leading to inhibition of protein synthesis.[5] In addition, UV radiation increases with altitude owing to less UV extinction by atmospheric particles and a shorter path through the atmosphere.[1] Therefore, high-altitude areas would have favorable conditions for inhibition and less spread of the virus in the environment. Consequently, there would be less probability of SARS-CoV-2 infection.
- Ozone: It is considered a frequent air pollutant, the concentration of which increases with altitude.[2] This molecule is associated with the production of free radicals that trigger oxidation reactions, which can affect proteins, lipids, and nucleic acids. Furthermore, the higher the ozone concentration in the air, the lower the probability of transmission of SARS-CoV-2.[7] Consequently, ozone would affect protein integrity (thiol group of cysteine) of the virus envelope, reducing the pathogenicity of SARS-CoV-2, and the beneficial effects of the increase in the concentration of atmospheric ozone should be apparent with increase in the altitude above the earth's surface.
- Wind speed: The vertical wind profile indicates that, in areas of higher altitude, the wind speed increases because the Earth's surface delays its speed.[3] Wind speed could reduce the survival of the virus in the air, by increasing the exposure of SARS-CoV-2 to solar radiation (ultraviolet light) and the dilution of airborne droplets. Consequently, the spread of SARS-CoV-2 infection would be decreased.

We postulate that these three typical factors of high-altitude areas would play an important role in the inactivation of SARS-CoV-2; the lesser the spread of the virus in the environment, the lower the possibility of infection. Furthermore, the study of the relationship between these factors, the spread of the virus, and the confirmed COVID-19 cases would explain the behaviors of the virus in different geographical areas. However, as pointed out by Pun et al,[4] it should also be considered that most SARS-CoV-2 transmission happens indoors where UV light and wind speed become immaterial; in addition, it is necessary to determine whether the amount of radiation between the wavelength of 200 and 300 nm present in sunlight is sufficient to damage SARS-CoV-2.

REFERENCES

1. Aceituno-Madera P, Buendía-Eisman A, Olmo FJ, Jiménez-Moleón JJ, Serrano-Ortega S. Melanoma, altitude, and UV-B radiation. *Actas Dermosifiliogr*. 2011;102:199–205. https://doi.org/10.1016/j.ad.2010.08.003.
2. Chevalier A, Gheusi F, Delmas R, et al. Influence of altitude on ozone levels and variability in the lower troposphere: a ground-based study for western Europe over the period 2001-2002. *Atmos Chem Phys*. 2007;7:4311–4326. https://doi.org/10.5194/acp-7-4311-2007.
3. Guevara Diaz JM. Quantification of the profile wind up 100m from surface and its incidence in air climatology. *Terra*. 2013;29:81–101.
4. Pun M, Turner R, Strapazzon G, Brugger H, Swenson ER. Lower incidence of COVID-19 at high altitude: facts and confounders. *High Alt Med Biol*. 2020;21:217–223. https://doi.org/10.1089/ham.2020.0114.
5. Wang Jiao, Shen J, Ye D, et al. Disinfection technology of hospital wastes and wastewater: suggestions for disinfection strategy during coronavirus Disease 2019 (COVID-19) pandemic in China. *Environ Pollut*. 2020;262:114665. https://doi.org/10.1016/j.envpol.2020.114665.

6. WHO. *Transmission of SARS-CoV-2: Implications for Infection Prevention Precautions*; 2020. https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions. Accessed July 12, 2020.
7. Yao M, Zhang L, Ma J, Zhou L. On airborne transmission and control of SARS-Cov-2. *Sci Total Environ*. 2020;731:139178. https://doi.org/10.1016/j.scitotenv.2020.139178.

J. Kenedy Ramirez*
Unidad de posgrado, Facultad de Farmacia y Bioquímica, Universidad Nacional de Trujillo, 13011, Peru

Vanessa Saldaña-Bobadilla
Departamento de Farmacotecnia, Facultad de Farmacia y Bioquímica, Universidad Nacional de Trujillo, 13011, Peru
E-mail address: vsaldanab@unitru.edu.pe

Celia Choquenaira-Quispe
Programa de Pós-graduação em Ciências Farmacêuticas, Universidade Federal do Ceará, Brazil
E-mail address: qfcelia@gmail.com

**Corresponding author.*
E-mail address: jramirezch@unitru.edu.pe

11 August 2020
Available online 28 December 2020

0377-1237/$ – see front matter

https://doi.org/10.1016/j.mjafi.2020.09.015