DO CLIMATE FACTORS INFLUENCE COVID-19 CLINICAL COURSE?

Abstract

The purpose of the present article is to explore the correlation between the trend of coronavirus transmission and the environmental factors, focusing on the climate different characteristics, all over the world. It has been shown that country's characteristics are more relevant than local seasonal conditions, such as crowded or poorly ventilated spaces. Regardless of the environmental characteristics like temperature and humidity that can have some influence in the virus persistence on different surfaces, the most effective factors to avoid contamination are social distancing and individual protection (masks and hygiene good practices) with different results according to environmental conditions and personal behaviour.

Introduction

Our last months were completely impacted to face new paradigms related to how we deal with our environment. Not only because we are more worried about climate changes, hurricanes, or other natural disasters, but because we faced new conditions, and even limitations, to deal with SARS-CoV-2/ COVID-19 in our daily lives. The WHO announcements and guidelines are helping countries and local communities to better deal with this Global Emergency, mainly to address good practices, from early detection, to quarantine procedures, and effective treatment [11].

Although the limited knowledge about the virus spread, diffusion, and contamination effectiveness, this article aims to verify and discuss how environmental aspects can be safe or dangerous towards virus transmission or social impact of it. Several factors must be taken into consideration, and the presented discussion will focus mainly on high-level conditions such as seasonal conditions, driven by ambient temperature and humidity.

Discussion

The COVID-19 virus seems to have different "behaviour" depending on several environmental factors, such as:

- local air humidity
- air temperature
- latitudes
- wind speed
- sunlight
- seasons

Individually or combined, these factors can create complex conditions that can differently categorize an ambient as safe or dangerous related to effective virus spread (Figure 1) [11]. Several studies ([1][3][5][8][10]) have discussed how the virus enters the body. The consensus states that the viral transmission to respiratory organs and exposed mucosae is the result of inhalation and skin-to-skin transmission from either infected people or contaminated hands. The main assumptions were created on previous findings related to similar SARS-CoV-2 viruses [8].
Although currently there is no scientific agreement on the details of SARS-CoV-2 persistence on surfaces, natural or artificial [11], on this regard some coronavirus previously evaluated can maintain its integrity for

at least several hours [7]. A 2020 study with high SARS-CoV-2 loads reported that the virus integrity is preserved longer at lower temperatures, like 4°C but as quickly compromised over 60°C [2]. This same study has confirmed that neutral pHs solutions can maintain virus-cell integrity longer. Those factors support WHO in its statement that heat, high or low pH and sunlight are capable to render coronavirus ineffective [11].
The spread of the virus through respiratory droplets is one of the main source of contamination, diffused by infected individuals whether symptomatic or not [11]. This is particularly relevant since aerosol spread is impacting significantly during medical procedures, which highlights the necessity of isolation of infected patients and support the fact that nursery personnel could be more contaminated than doctors [10].

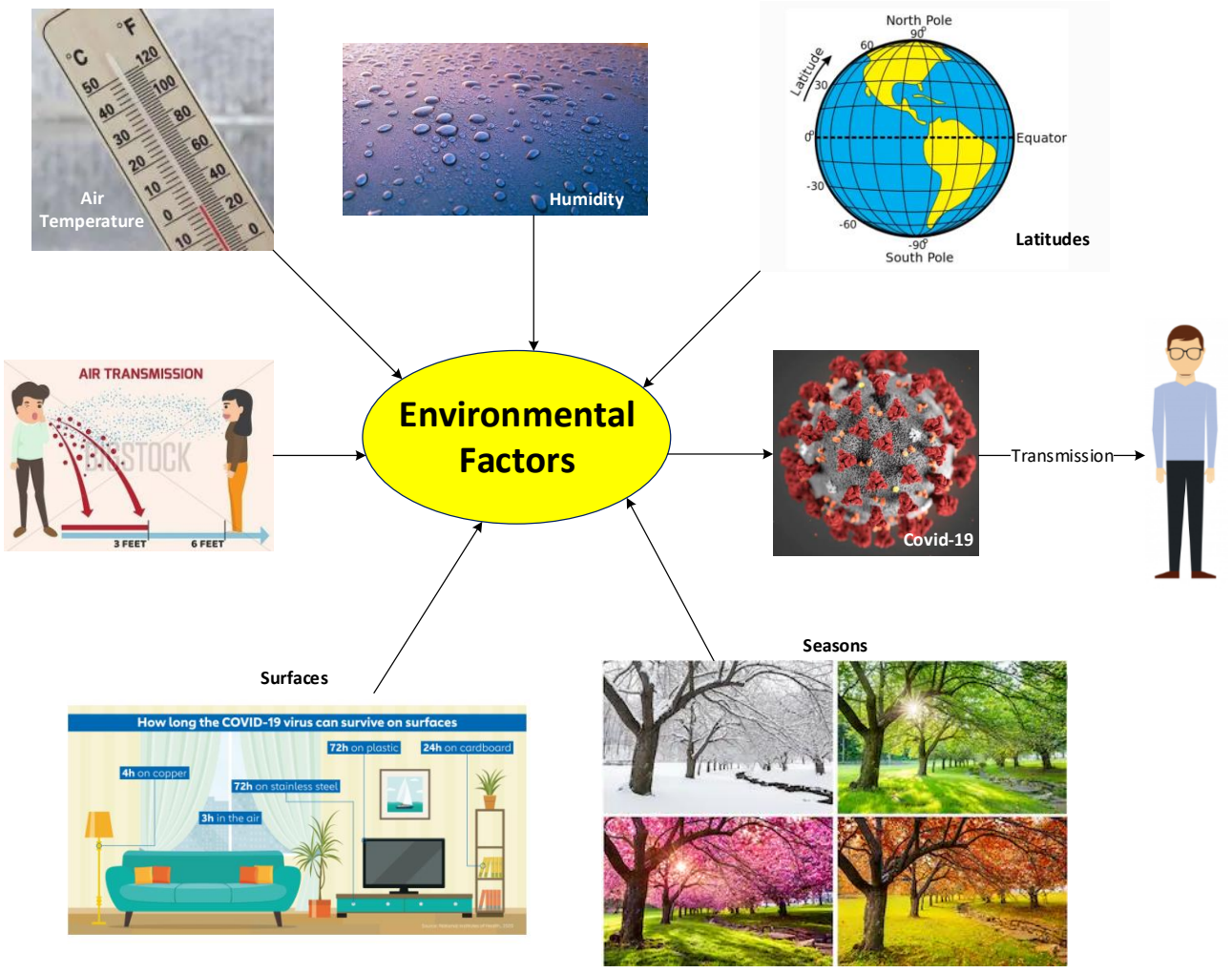

Figure 1: Environmental factors that may affect the COVID-19 transmission

Recent studies show that the SARS-Cov-2 infectivity and mortality are correlated with the air humidity since its transmission happens through droplets, which last longer in humid air and wet surfaces [1]. To easily explain how humidity can keep the virus integrity longer in the air we can think about the behaviour of a wet towel which needs more time to get dry in a humid environment. Longer the virus remain inside water droplets, it keeps its cell integrity.
The “virus-humidity” hypothesis is related to the infection capability of the virus towards the human body: dry weather usually causes an overly dry respiratory mucosa, which leads to the first, light, impairment of this barrier against the virus infection. On top of this, high wind speed can increase the “distance” the infected droplet can travel hence survive in the air [2]. On another hand, ventilated spaces spread the

droplets more efficiently, which reduce the virus load per area and, as a consequence, the infection capability.

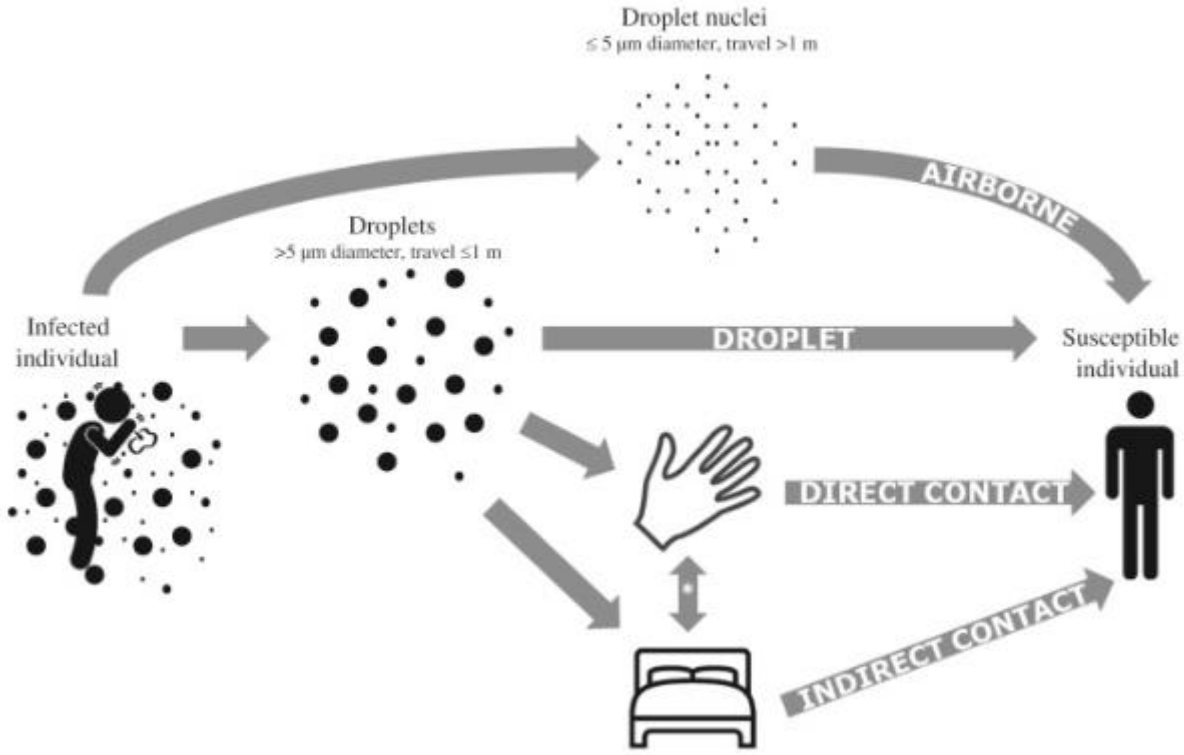

Figure 2: Covid-19 transmission routes

Different studies have shown that the viability of viruses is strongly dependent on temperature. Transmission of influenza can be reduced under high-temperature conditions. It has been proven that high temperatures can effectively deactivate viruses, resulting in a large reduction in the number of active viruses [3]. A study conducted in China has confirmed that a 1°C temperature increase can influence in 0.86% fewer cases number cumulatively [9].

A recent study has shown that the relationship between the prevalence of COVID-19 with maximum air humidity and wind speed was negligible and statistically not significant [3]. Although, in most cases, with increasing humidity and wind speed, the prevalence has decreased. The association between COVID-19 prevalence and maximum ambient temperature was negligible to moderate. Also, with increasing temperature in most of the studied cities, the prevalence of the disease has decreased [1].

Since the climate factors are so various the best way to analyse the trend of the coronavirus is to focus on one country at a time or at least to compare country belonging to the same climate zones. Moreover, it is important to consider that the trend of the number of active cases is not only dependent on climate factors but it is highly affected by social behaviour and local government directions.

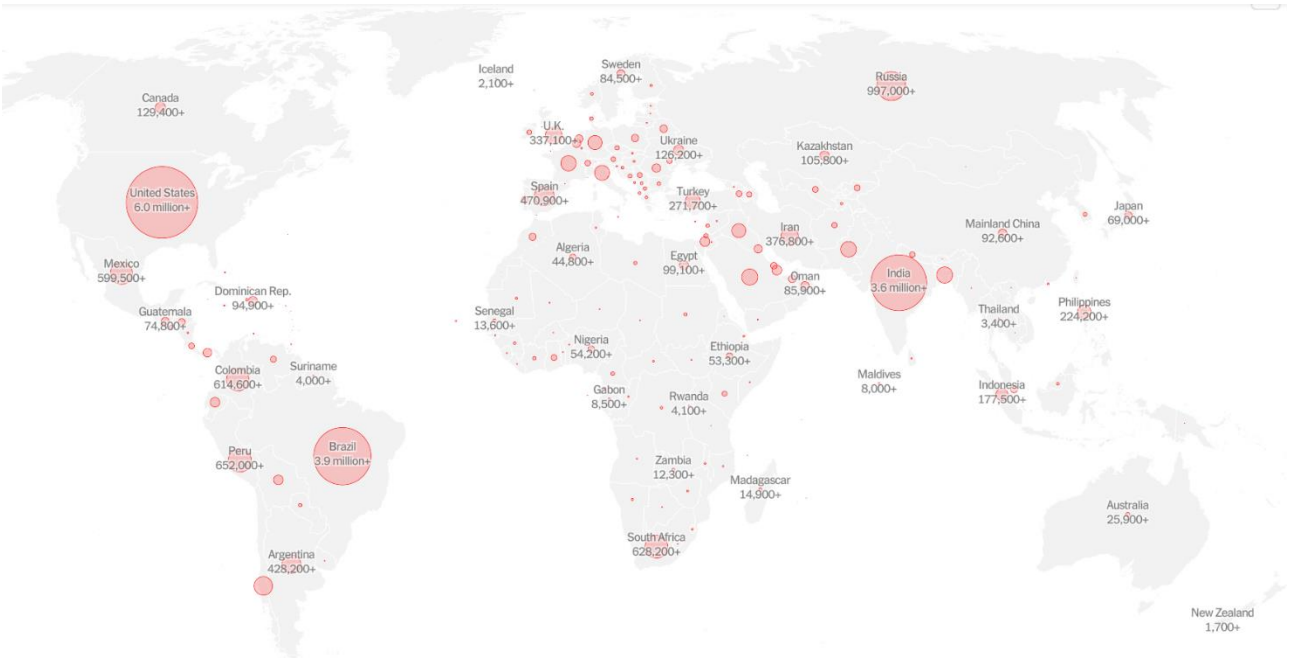

Figure 3: Map of Covid-19 confirmed cases at September, 1st 2020: the bigger circle is correlated with the higher number of cases. Source: npr.org

In ***Italy,*** Covid-19 has mainly affected regions such as Lombardy, Veneto, Emilia Romagna and Piedmont from the North in which the air temperature is lower and the air humidity is higher than the south of Italy. Moreover, the trend of active cases shows a decrease with the arrival of summer.

Figure 4: Trend of active cases in Italy among 23rd February and 28th June 2020

In ***Turkey*** recent studies [3] demonstrate that the higher average wind speed is closely related to the higher number of COVID-19 cases. Moreover, the higher number of active cases arises from the lower temperature on a day.

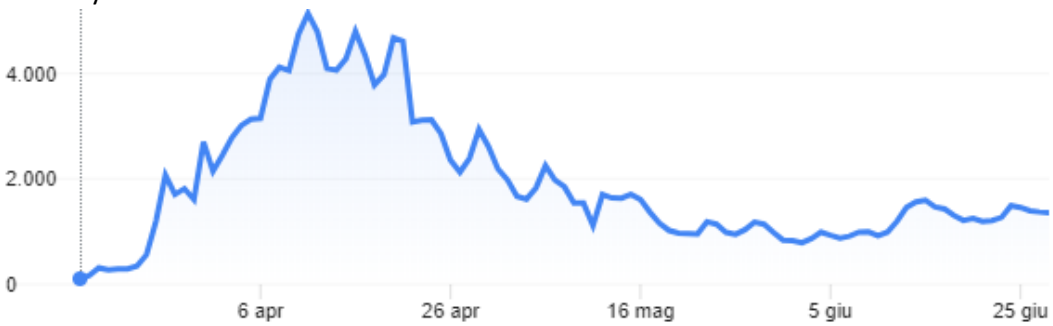

Figure 5: Trend of active cases in Turkey among 18th March and 28th June 2020

In ***Mexico,*** the increase in the number of cases has occurred during the wet season and it keeps increasing during summer days.

Figure 6: Trend of active cases in Mexico among 18th March and 28th June 2020

In ***Brazil,*** the arrival of the winter has led to a significant increase in the number of cases, faster them north hemisphere countries.

Figure 7: Trend of active cases in Brazil among 14th March and 28th June 2020

Those data does not support any significant correlation between seasonal characteristics and the SARS-CoV-2 spread. As discussed before, hotter places with higher humidity can configure a danger ambient to keep the virus-cell stability in the environment and, as a consequence, force a higher contamination risk. Some new data shown by National Health Organizations confirm that even countries that had a hotter summer season, have not eliminated the virus and new contamination cases have been recently reported, as graphically represented in Figure 8. The combination of individual habits like touching hands, face, mouth and eyes and non-hygienic actions will be the predominant factors supporting virus diffusion and contamination regardless of the good practices of social distancing and body and surfaces cleaning.

On top of that, new recommendations have been published to support decision-makers and local communities in the discussion and establishment of social rules to decrease as far as possible new contaminations. The most important factors, besides the seasonal (temperature and humidity) characteristics, are social distancing, individual protection, time of contact, environmental conditions (ventilation) and type of human contact [5]. Figure 9 summarizes the last applicable suggestions to evaluate the contamination risk level.

	▼TOTAL CASES	PER 100,000	CASES IN LAST 7 DAYS	PER 100,000	WEEKLY CASES PER CAPITA (FEWER – MORE; Jan. 22 – Aug. 31)
United States MAP »	6,087,779	1,861	290,637	89	
Brazil MAP »	3,908,272	1,866	285,411	136	
India MAP »	3,691,166	273	523,843	39	
Mexico MAP »	599,560	475	35,855	28	
Spain MAP »	470,973	1,008	57,422	123	
Argentina	428,239	962	66,868	150	
France MAP »	286,007	427	36,171	54	
Turkey	271,705	330	10,441	13	
Italy MAP »	270,189	447	8,916	15	
Germany MAP »	243,599	294	7,528	9	

Figure 8: SARS-CoV-2 public data with graphic per capita weekly cases from Jan 22nd and 31st August 2020. Source: extraction of The New York Times web site nytimes.com

Type and level of group activity	Low occupancy			High occupancy		
	Outdoors and well ventilated	Indoors and well ventilated	Poorly ventilated	Outdoors and well ventilated	Indoors and well ventilated	Poorly ventilated
Wearing face coverings, contact for short time						
Silent						
Speaking						
Shouting, singing						
Wearing face coverings, contact for prolonged time						
Silent						
Speaking		*		*		
Shouting, singing						
No face coverings, contact for short time						
Silent						
Speaking						
Shouting, singing						
No face coverings, contact for prolonged time						
Silent						
Speaking						
Shouting, singing						

Risk of transmission
Low Medium High

* Borderline case that is highly dependent on quantitative definitions of distancing, number of individuals, and time of exposure

Figure 9: Risk of SARS-CoV-2 transmission [5].

Conclusion

The findings suggest that there is an optimal climatic zone in which the concentration of Covid-19 increases in the ambient environment (including the pollution and the surfaces of an object) but the climate factors are not as relevant as the social conditions which characterize each country. The last evaluations against the virus spreading in several countries does not shown relevant difference between tropical or sub-tropical zones, including evaluation inside the same country such as United States, Brazil, Mexico and India. The main factors that can individually and collectively reduce the risk of transmission of SARS-CoV-2 are to keep social distancing, use individual protection, avoid long time permanence in poorly ventilated environments and crowded spaces wherever being in a warm or cold season.

Glossary

Aerosol generating	when the surface tension of fluid lining the respiratory tract is overcome by by the type and force of respiratory activity

References

[1] Bhattacharjee S (2020) Statistical investigation of relationship between spread of coronavirus disease (COVID-19) and environmental factors based on study of four mostly affected places of China and five mostly affected places of Italy. arXiv preprint arXiv :2003.11277

[2] Chin A, Chu J, Perera M, Hui K, Yen H-L, Chan M, Peiris M, Poon L (2020) Stability of SARS-CoV-2 in different environmental conditions. medRxiv. https://doi.org/10.1101/2020.03.15.20036 673

[3] Eslami, H., Jalili, M. The role of environmental factors to transmission of SARS-CoV-2 (COVID-19). AMB Expr 10, 92 (2020). https://doi.org/10.1186/s13568-020-01028-0

[4] Irina V.Biktasheva, "Role of a habitat's air humidity in Covid-19 mortality", Science of the Total Environment 736 (2020) 138763

[5] Jones, N. R., Qureshi, Z. U., Temple, R. J., Larwood, J. P., Greenhalgh, T., & Bourouiba, L. (2020). Two metres or one: What is the evidence for physical distancing in covid-19? Bmj, M3223. BMJ 2020; 370 doi: https://doi.org/10.1136/bmj.m3223 (Published 25 August 2020)

[6] M.Sahin, "impact of weather on COVID-19 pandemic in Turkey", Science of the Total Environment 728 (2020) 138810

[7] Parry J (2004) WHO queries culling of civet cats. BMJ 328:128. https://doi.org/10.1136/bmj.328.7432.128-b

[8] Sun CB, Wang YY, Liu GH, Liu Z (2020) Role of the eye in transmitting human coronavirus: what we know and what we do not know. Front Public Health 8:155. https://doi.org/10.3389/fpubh.2020.00155

[9] Wang M, Jiang A, Gong L, Luo L, Guo W, Li C, Zheng J, Li C, Yang B, Zeng J, (2020) Temperature significant change COVID-19 Transmission in 429 cities. MedRxiv. https://doi.org/10.1101/2020.02.22.20025 791

[10]Wilson NM, Norton A, Young FP, Collins DW. Airborne transmission of severe acute respiratory syndrome coronavirus-2 to healthcare workers: a narrative review. Anaesthesia. 2020;75(8):1086-1095. doi:10.1111/anae.15093

[11]World Health Organization, International website and official publications (www.who.int)

[12]Z Huang et al. / "Optimal temperature zone for the dispersal of Covid-19", Science of the Total Environment 736 (2020) 139487