Open Access

Journal of Clinical Immunology & Microbiology

Research Article

Deforestation, Air Pollution and Brazilian COVID-19 Variant

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Received Date: 26-01-2021; **Accepted Date:** 15-02-2021; **Published Date:** 23-02-2021

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Abstract

Aim of this work is to submit to the researcher the relationship whit climate condition, air pollution and deforestation in Manaus zone in Brazil and the rapid spread of so called Brazilian COVID-19 variant.

Also other situation are analysed like South Africa variant.

This topics of research make possible to better study the phenomena of new COVID-19 variant explosion and related effect on increase velocity in spread and in increased mortality rate in some region of the world. The ability of this variant to elude immune system need to seek also in environmental toxicology some response.

Luisetto M | Volume 2; Issue 1 (2021) | JCIM-2(10)-016 | Research Article

Citation: Luisetto M, et al. Deforestation, Air Pollution and Brazilian COVID-19 Variant. J Clin Immunol Microbiol. 2021;2(1):1-19.

DOI: <http://dx.doi.org/10.46889/JCIM.2021.2103>

Keywords

Environmental Toxicology; Air Pollution; Deforestation; Atmospheric Chemistry; Climate Condition; COVID-19; Coronavirus, Brazilian Variant; Mortality Rate; Velocity of Diffusion; Immune System Evasion

Abbreviations

ATTO: Amazon Tall Tower Observatory; CO₂: Carbon dioxide; CM: Carbon Monoxide; NO_x: Nitrogen Oxides; NMVOCs: Non-Methane Volatile Organic Compounds; BC: Black Carbon; OC: Organic Carbon; RPGCC: Research Program on Global Climate Change; SOA: Secondary -Organic Aerosols; VOC: Variants of Concern; RBD: Receptor-Binding Domain; WGS: Whole Genome Sequencing

Introduction

Related actual spread of so called BRASILIAN VARIANT COVID-19 in region of MANAUS and to its specific mortality rate and velocity in diffusion it is interesting to observe the impact of some phenomena like air pollution due by also deforestation and fraudulent fire.

Researchers find very high rates of COVID-19 in the Brazilian Amazon (Dec 2020): University of Oxford news.

By testing approximately 1,000 blood donation samples each month in in the Brazilian -cities of São Paulo and Manaus, an international team of researchers have shown that, while both cities have experienced large epidemics of COVID-19 with high-mortality, as much as three-quarters of the population in Manaus was infected between March - October and a third of the population in São Paulo.

According Healthcare and Pharma MAY 8, 2020 as deaths mount in Brazil's Amazon, official COVID-19 toll under scrutiny By Jake Spring, Eduardo Simões, Bruno Kelly: The largest of 9 states in Brazil's Amazon rainforest, Amazonas has registered nearly 19.4 coronavirus- deaths per 100,000 residents, compared to 4.4 for all of Brazil, according to a Reuters, calculation based on the death toll released by the federal health ministry.

The coronavirus COVID-19 killed 422 people in Amazonas in April, according to the ministry. Yet death registry data from public notaries indicates the ministry's statistics may far underestimate the actual toll.

The Guardian Jan 2021: COVID-19 eruption in Brazil's largest state leaves health workers begging for help "Amazonas and particularly its riverside- capital Manaus, were pummelled

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by the epidemic's first- wave last April, when authorities were forced to dig mass graves for victims” and from Monitoring air pollution from fires 09/09/2019 ESA / Applications / Observing the Earth / Copernicus / Sentinel-5P “The wildfires that have been devastating the Amazon- rainforest have been international headline news over the last weeks. These fires are not only an environmental tragedy in terms of lost forest and biodiversity, but they are also leaving their mark on the atmosphere, affecting air- quality and potentially, the global- climate.

The satellite -carries the state-of-the-art Tropomi instrument to map a multitude of trace gases such as nitrogen dioxide, ozone, formaldehyde, sulphur dioxide, methane, carbon- monoxide and aerosols - all of which affect the air we breathe.”

It is really interesting that in this region it is observed a great and rapid diffusion of COVID-19 new variant with great influence in public health of population (Fig. 1).

Figure 1: Image showing situation in Brazil.

Amazon Tall Tower Observatory (ATTO)

Earth system research in the Amazon rainforest in this part of the world, the predominant wind-direction is North-East, due to trade winds blowing from the Atlantic Ocean. This puts ATTO upwind from Manaus and its air pollution. Air masses reaching the site from to the North-East are near-pristine, mainly unaffected by human activities. The closest cities in that direction are Santarém and Belém at distances of 500 km and 900 km away. The rest of the area is covered in rainforest. But this is only true during the wet- season.

During the dry- season, the wind direction shifts more often to East and South-East. Air masses from this direction pass over agricultural areas and regions more affected by deforestation.

Additionally, this is the time of year when the frequency of natural and man-caused fires increases. Thus, the wind brings more pollutants to ATTO.

These contrasting regimes allow us to compare a near-pristine atmosphere to one notably influenced by human activity (Fig. 2-8).

Figure 2: Fire in amazon forest From NASA.

Figure 3: Amazon deforestation.

Figure 4: Deforestation South America.

Amazon rainforest fires cannot be defined as natural

Figure 5: Amazon forest fire.

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Figure 6: Amazon fire counts.

Figure 7: Amazon forest fire.

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Figure 8: MANAUS pollution system. This phenomenon affects cloud production and rainfall, with consequences for the local and global- climate, which researchers have warned about in the study published in Nature- Communications.

According to S Wu, air pollution 24 May 2015, fire influences on atmospheric composition, air quality and climate. Field current pollution reports fires can have wide-ranging effects on surface air quality, both in the tropics and extra-tropics. In general, health effects of key anthropogenic pollutants such as particulate- matter (i.e. aerosols) and ozone have been investigated extensively, with some studies even documenting global- effects.

There are both gaseous and aerosol emissions from fires and associated biomass burning. Carbon dioxide (CO_2), Carbon Monoxide (CM), Nitrogen Oxides (NO_x) and Non-Methane Volatile Organic Compounds (NMVOCs) are the most important emitted- gases, While Black Carbon (BC) and Organic Carbon (OC) are the most important aerosol- species. CO_2 emissions can have important implications for CO_2 concentrations and understanding the carbon- cycle but do not directly affect atmospheric chemistry or contribute to air quality degradation. Other carbonaceous- emissions (BC, OC, CO, NMVOCs and methane (CH_4), for which biomass burning is only a minor source) and NO_x can be important for both air pollution/chemistry and climate. NO_x , NMVOCs, CO and methane are important precursors of tropospheric ozone, which is a secondary- pollutant and is not directly emitted by fires. For the Brazilian amazon, using surface in situ measurements, it was found that concentrations of submicron aerosols reached $100 \mu\text{g m}^{-3}$ during biomass burning events in September/October 2012, with organic aerosols largely dominating the aerosol mass (Fig. 9).

Figure 9: COVID-19 Cases in BRAZIL in the month of September 2020.

Material and Methods

With an observational and visual methods some maps and figure are submitted to the researcher in order to show relationship if present between some air pollution condition , deforestation of amazon and the rapid spread of Brazilian COVID-19 new variant.

A scientific literature search is performed to list article of interest for the scope of this work. All publications comes from scientific database or other relevant publishers.

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It is also submitted a research project as instrument to verify the hypothesis under investigation and relationship. After this phases a global conclusion is produced.

Results

According to an article on the study published in Nature-Communications, urban -pollution results in an average increase of 200% in the formation of secondary organic- aerosols, with spikes of up to 400%. FAPESP supported the study as part of the Green Ocean Amazon Experiment (GO Amazon) and a Thematic Project linked to the Research Program on Global Climate Change (RPGCC). Pollution from Manaus increases the formation of aerosols via the forest itself. NO_x emitted from Manaus increases the levels of OH and ozone (brown- arrows), which accelerates the oxidation of carbon naturally emitted by the forest in the forms of isoprene and terpene (green- arrows). In the absence of urban pollution, soil emissions of NO_x (purple arrows) also drive the oxidation cycle but at far lower levels [1].

According to Manish Shrivastava, et al., “one of the least understood aspects in atmospheric - chemistry is how urban- emissions influence the formation of natural organic- aerosols, which affect earth’s energy budget. The Amazon rainforest, during its wet season, is one of the few remaining places on earth where atmospheric- chemistry transitions between preindustrial and urban-influenced conditions. Here, we integrate insights from several laboratory measurements and simulate the formation of Secondary -Organic Aerosols (SOA) in the Amazon using a high-resolution chemical transport model. Simulations show that emissions of nitrogen-oxides from Manaus, a city of ~2 million people, greatly enhance production of biogenic SOA by 60-200% on average with peak enhancements of 400%, through the increased oxidation of gas-phase organic carbon emitted by the forests. Simulated enhancements agree with aircraft measurements and are much larger than those reported over other locations. The implication is that increasing anthropogenic- emissions in the future might substantially enhance biogenic-SOA in pristine locations like the Amazon” [2].

Researchers from Imperial's COVID-19 response team and a team of international collaborators found that 76% population in Manaus became infected with SARS-CoV-2 between March and October- 2020.

In contrast, they find that 29% became infected in São- Paulo, the first city detecting SARS-CoV-2 circulation in Latin- America [3].

This variant, known as P.1 or VOC202101/02 in the UK, was first detected in travellers from Brazil who arrived in Japan in January 2021. It involves 17 unique amino acid changes, three deletions, four synonymous -mutations and one 4nt insertion. It has several mutations that are known to be biologically- important, including E484K and N501Y.

The N501Y- mutation, which is also a feature of the English variant, has been linked to increased infectivity and virulence in mouse models [2]. Meanwhile, the E484K mutation is thought to be associated with escape from the neutralizing- antibodies produced by the body against SARS-CoV-2 [3]. This mutation is present in the South African variant as well [4].

Since the emergence of the coronavirus disease 2019 (COVID-19), a few cases of reinfection with phylogenetically distinct variants of SARS-CoV-2 have been reported. These re-infection cases might be the consequence of a limited and transitory protective immunity induced by the primo-infection or might reflect the reinfecting virus's ability to evade the previous immune-responses. The rapid -spread in the United Kingdom and South Africa of emerging SARS-CoV-2 variants carrying several mutations in the Receptor-Binding Domain (RBD) of the Spike (S) protein granting them the title of Variants of Concern (VOC) [2,3]. Among these mutations, E484K and N501Y are of particular concern since they potentially- reduce antibody neutralization and increase affinity for ACE2 receptor [4-10]. Of note, the first official record of a reinfection case with the emerging VOC B.1.1.7 circulating in the UK was recently published [5].

The P.1 variant has so far only been identified in Brazil and in travellers from Brazil (mostly from the Amazonas- State) reported in Japan and South- Korea. The capital of Amazonas, Manaus, is currently experiencing an upsurge in COVID-19 cases, putting significant pressure on the healthcare system.

ECDC assesses the probability of the introduction and community- spread of variants of concern in the EU/EEA as very high due to their increased- transmissibility. Such an increased transmissibility is likely to lead to an increased number of infections. This, in turn, is likely to lead to higher hospitalisation and death rates across all age-groups, but particularly for those in older- age groups or with co-morbidities. Consequently, stricter NPIs are needed to reduce transmission and relieve the pressure on healthcare systems. Therefore, the impact of introduction and community spread is considered to be high. The overall risk associated with the introduction and community- spread of variants of concern is therefore assessed as being high/very high [6].

Fire incidence increased by 36% during the 2015 drought compared to the preceding 12 years. The 2015 drought had the largest ever- ratio of active fire counts to de-forestation, with active fires occurring over an area of 799,293 km² [7].

Oliveira, et al., and Rocha, et al., argue that the fires from the increasing deforestation, combined with the drought and wild-fires, worsens respiratory health risks, including the COVID-19 cases, increasing the demand for health- services and the locomotion to cities [8].

Gabriel de Oliveira, a post-doctoral researcher with Professor Jing Chen in the department of geography and planning in the University of Toronto's Faculty of Arts and Science, says breathing difficulties and respiratory challenges brought on by the coronavirus are being

exacerbated by the ecological crisis that had been developing in the amazon over several- years (Fig. 10,11) [9].

Figure 10: Deforestation and COVID-19 cases amazon.

Deforestation is a powerful and consistent variable in explaining the transmission of COVID-19 coronavirus to indigenous populations [10].

Figure 11: In the Amazon region, particles from biomass burning and urban -pollution

account for CA. 30 % of all particulate matter, while the rest comes from biogenic- sources. The team also found a much higher overall concentration of particulate matter PM during the dry season. This is in part because of the increase in particles from anthropogenic- sources. But the amount of particles from biogenic -sources also increases during that time. But even though the anthropogenic fraction of particulate matter is relatively low, they absorb much more light than biogenic- particles do. This, in short, makes the air warmer. Biogenic particles reflect more light, counteracting the greenhouse effect to some degree.

Recent published study in Atmospheric Chemistry and Physics says black carbon is an air pollutant that is harmful to human- health and also contributes to global- warming. It is emitted in combustion processes, for example in industry, power- plants and diesel engines, through the burning of wood and waste and in wildfires in forest and grassland areas. In southern-Africa, the Johannesburg/Pretoria Metropolitan -Area is particularly affected by air pollution. The main pollution sources there are coal-fired power plants, open fires and savanna fires [11,12].

Fast-spreading lineage: Much of the concern centres on a variant that researchers identified in South Africa in late 2020. A team led by Tulio de Oliveira, a bio-informatician at the University of KwaZulu-Natal in Durban, South- Africa, linked the variant called 501Y.V2 to a fast-growing epidemic in Eastern Cape province that has since spread across South- Africa and into other countries. The lineage carries many mutations in the SARS-CoV-2 spike protein the immune system's prime target, which allows the virus to identify and infect host cells including some changes linked to weakened antibody activity against the virus [13].

Globally, numerous pollution- hotspots have been identified using satellite-based instruments. One of these hot-spots is the prominent NO₂ hotspot over the South African Highveld. The tropospheric NO₂ column density of this area is comparable to that observed for central and northern- Europe, eastern North America and south-east Asia. The most well-known pollution source in this area is a large array of coal-fired power stations. Upon closer inspection, long-term means of satellite observations also show a smaller -area, approximately 100 km west of the Highveld hotspot, with a seemingly less substantial NO₂ column density. This area correlates with the geographical location of the Johannesburg-Pretoria conurbation or megacity, one of the 40 largest metropolitan- areas in the world. Ground-based measurements indicate that NO₂ concentrations in the megacity have diurnal- peaks in the early morning and late afternoon, which coincide with peak traffic hours and domestic combustion. During these times, NO₂ concentrations in the megacity are higher than those in the Highveld -hotspot. These diurnal NO₂ peaks in the megacity have generally been overlooked by satellite observations because the satellites have fixed local overpass times that do not coincide with these peak-periods. Consequently, the importance of NO₂ over the megacity has been underestimated. We examined the diurnal cycles of NO₂ ground-based measurements for the two areas - the megacity and the Highveld hotspot and compared them with the satellite-based NO₂ observations. Results show that the Highveld hotspot is accompanied by a second- hotspot over

the megacity, which is of significance for the more than 10 million people living in this mega city (Fig. 12-14) [14].

Figure 12: Satellite image of tropospheric vertical NO₂ column (in 10^{15} molecule/cm²) over the South African Highveld.

Figure 13: Image showing the air pollution conditions in UK.

Figure 14: UK new COVID -19 variant December 2020.

From ECDC, viruses constantly change through mutation and so the emergence of new-variants is an expected occurrence and not in itself a cause for concern; SARS-CoV-2 is no exception. A diversification of SARS-CoV-2 due to evolution and adaptation- processes has been observed globally.

While most emerging mutations will not have a significant- impact on the spread of the virus, some mutations or combinations of mutations may provide the virus with a selective advantage, such as increased transmissibility or the ability to evade the host immune response. In such cases, these variants could increase the risk to human- health and are considered to be variants of concern.

New variants of current concern The United Kingdom has faced a rapid increase in COVID-19 case rates in the South-East, the East and the London area, which is associated with the emergence of a new SARS-CoV-2 variant, VOC 202012/01. As of 26 December 2020, more than 3,000 cases of this new- variant, confirmed by genome sequencing, have been reported from the UK. An increasing proportion of cases in the South East, the East and the London area are due to this variant, but cases have also been identified in other parts of the UK. Although it was first reported in early December, the initial cases were retrospectively identified as having emerged in late September.

Preliminary analyses indicate that the new- variant has increased transmissibility compared to previously circulating- variants, but no increase in infection severity has so far been identified. Since 26 December, a few VOC 202012/01 cases have also been reported in other EU/EEA countries (Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, the Netherlands, Norway, Portugal, Spain and Sweden) and globally (Australia, Canada, Hong Kong SAR, India, Israel, Japan, Jordan, Lebanon, South Korea, Switzerland, Singapore).

In addition to VOC 202012/01, South Africa has reported another SARS-CoV-2 variant, designated as 501.V2, which is also of potential concern. This variant was first observed in samples from October and since then more than 300 cases with the 501.V2 variant have been confirmed by Whole Genome Sequencing (WGS) in South Africa, where it is now the dominant form of the virus. Preliminary results indicate that this variant may have an increased transmissibility. Like the VOC 202012/01, at this stage there is no evidence that 501.V2 is associated with higher severity of infection. On 22 December 2020, two geographically separate cases of this new variant 501.V2 were detected in the UK. Both are contacts of symptomatic individuals returning from travel to South Africa. On 28 December 2020, one additional case of this new variant was detected in Finland in a returning traveller from South Africa [14].

According Allison J, et al., the evolution of SARS-CoV-2 could impair recognition of the virus by human antibody-mediated immunity. To facilitate prospective surveillance for such evolution, we map how convalescent serum antibodies are impacted by all mutations to the spike's Receptor Binding Domain (RBD), the main target of serum neutralizing activity. Binding by polyclonal serum antibodies is affected by mutations in three main epitopes in the RBD, but there is substantial variation in the impact of mutations both among individuals and within the same individual over time. Despite this inter- and intra-person heterogeneity, the mutations that most reduce antibody binding usually occur at just a few sites in the RBD's receptor binding motif. The most important site is E484, where neutralization by some sera is reduced >10-fold by several mutations, including one in emerging viral lineages in South Africa and Brazil. Going forward, these serum escape maps can inform surveillance of SARS-CoV-2 evolution [16].

Experimental Project Hypothesis

In order to verify association between air pollution level and new COVID-19 variant it is crucial to collect epidemiological data related this virus spread, mortality rate, cases and the data related air pollution.

Period of observation: 2020-2021 (first wave, second wave)

Variant to be observed: Significates variant responsible of increased spread and mortality rate (about more then 20-30%).

After this epidemiological and environmental toxicology data collection is possible to verify if there is or not a significates correlation.

Another data to be collect is related human factor artificial air pollution production (yes or not) in order to verify antropogenic effect (Table 1).

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Region	High Air Pollution	New COVID-19 Variant
Wuhan	Yes	
North Italy	Yes	
UK	Yes (South)	Yes
Manaus- Brazil	Yes	Yes
South Africa	Yes	Yes

Table 1: Region showing relation between air pollution and COVID-19 new variant.

Chi-square Statistic Test

In this, some definition are used (choose by authors)

High air pollution: 30, normal level 1

Presence of variant: 2, Absence: 1 (Table 2)

	South UK	Manaus	South Africa	Madagascar	Italy Great Isle	Row Totals
High Air Pollution	30 (29.44) [0.01]	30 (29.44) [0.01]	30 (29.44) [0.01]	1 (1.84) [0.38]	1 (1.84) [0.38]	92
Variant	2 (2.56) [0.12]	2 (2.56) [0.12]	2 (2.56) [0.12]	1 (0.16) [4.41]	1 (0.16) [4.41]	8
Column Totals	32	32	32	2	2	100 (Grand Total)
The chi-square statistic is 9.9864. The p-value is .040657. The result is significant at $p < .05$.						

Table 2: Chi-square statistics results.

Discussion

From above literature, it is clear the impact of air pollution in the spread of COVID-19 especially due by carriers like PM 2.5, PM 10 but also due by the pro inflammatory effect of some pollutants in respiratory tract (NO₂, ozone and other).

It is also clear that fire and burn in some amazon forest produce an increase of air pollutants and also CO₂ production.

Observing the images related amazon fire and burns, air pollution in zone like MANAUS and the prevalence of a new variant of COVID -19 need some consideration.

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It is possible that some aggravating environmental factors increase the probability of selection of new COVID-19 variant? To give response in this question it is interesting to observe the new variant of COVID-19, the country and region of origin and related air pollution level (UK variant, South Africa variant).

Conclusion

The high mortality rate in some Brazilian region, the rapid spread of new dangerous COVID-19 variant. It is must to consider the air pollution as modified in last year. Fire that seem artificially produced, it is possible that great foci of COVID -19 spread comes from great polluted region? (Wuhan, North Italy, South Africa and so on).

Observing the maps of air pollution in some region and the related mortality rate make possible to verify if a relationship can be considered to explain such epidemiological phenomena. It interesting to observe the high level of air pollution in region high affected by new variant (MANAUS region, UK variant, South Africa variant).

Air pollution is recognized as a worsening environmental toxicological factor that affect spread and mortality rate but it is interesting verify also if it can be a kind of pressure in selecting new variant.

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