

Ministério da Saúde FIOCRUZ Fundação Oswaldo Cruz

# **BRAZILIAN AMAZON:** POTENTIAL IMPACTS OF WILDFIRES ON HUMAN HEALTH In the context of the covid-19 expansion



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### **INTRODUCTION**

World leader in tropical deforestation, Brazil saw the degradation of the Amazon increase between the years 2019 and 2020. Historically, fires have been part of the dynamics of deforestation in the Amazon. The deforested areas are subsequently burned to transition between different land use changes - that is, to "clear" the land, making room for pasture, agriculture, or simple land speculation.

The cycle of fires in the Amazon is observed during the dry season (from July to October, peaking in September), with serious social, environmental, and mainly human health impacts. With a significant increase in demand for primary care services and hospitalizations for respiratory and cardiovascular diseases, with worsening of the clinical picture, especially in the most vulnerable groups, such as pregnant women, children, the elderly, brigadiers, firefighters, traditional populations and people who have respiratory diseases. and chronic cardiovascular diseases. Thus, in addition to the effects on the Amazon biome, deforestation and fires have direct and indirect impacts on human health, affecting the health of the populations of the Amazon in a particularly severe way.



### **SUMMARY**

- The study, object of this technical note, evaluated the percentages of hospital admissions (hospital morbidity) that can be attributed to the concentration of air pollutant particles emitted by fires (fine inhalable particles) in the Amazonian states with the highest number of hot spots in the last few 10 years: Pará, Mato Grosso, Rondônia, Amazonas and Acre.
- The percentage of hospital admissions for respiratory diseases in the region remained stable between 2010 and 2020, but a considerable part of these admissions can be attributed to the concentrations of fine inhalable particles emitted by forest fires.
- Even with the possible underreporting, due to inconsistencies in the DataSUS database, the study showed that extremely high daily values of pollutants contributed to double the risk of hospitalization for respiratory diseases attributable to the concentration of inhalable particles (smoke) in the analyzed states.



### BRAZILIAN AMAZON: Potential impacts of wildfires on human health in the context of the expansion of covid-19



The Covid-19 global pandemic, declared on March 11, 2020 by the World Health Organization (WHO), raised concerns about the health impacts caused by pollutant emissions from wildfires.

As it is a respiratory disease produced by a pathogen, the SARS-CoV-2 virus, which can remain viable for hours in aerosols (particles that are suspended in the air) (Van Doremalen et al., 2020), the relationship between the effect of air pollution on COVID-19 infection has become the subject of many studies. Pollutants from wildfires can cause a persistent inflammatory response and, thus, increase the risk of infection by viruses that reach the respiratory tract (Travaglio et al., 2021).

The microparticles that make up the smoke are deposited in the terminal bronchi and in the alveoli, aggravating respiratory problems. Therefore, chronic smoke exposure causes individuals most vulnerable to COVID-19 to have more severe forms of the infection (Wu et al., 2020). Although the impacts (air pollution) on airborne transmission of the virus are a study under development for the Brazilian Amazon, preliminary evidence confirms that SARS-CoV-2 may be present in particulate matter (Setti et al., 2020). This is one of the hypotheses for the contribution of the spread of the SARS-CoV-2 virus in Brazil's Legal Amazon, since the virus can potentially be transported to the pulmonary alveoli on the surface of the microparticles (Schraufnagel et al., 2019). Fine particles, such as PM2.5, have a longer residual time in the atmosphere than coarse particles and can be transported over long distances, which increases their dispersion capacity and, consequently, their impact on a spatial scale, which can reach to urban areas. Inhalable particles have a greater impact on human health, and are defined in a simplified manner as MP10, those whose aerodynamic diameter is less than 10 µm (micrometer), and MP2.5, which have aerodynamic diameter less than 2.5 µm.

- In Pará, Mato Grosso, Rondônia and Amazonas, 70% of registered hospital admissions are related to respiratory diseases associated with high concentrations of pollutant particles emitted by wildfires.
- In Amazonas, 87% of hospital admissions for hospital illnesses in the analyzed period are related to high concentrations of fine inhalable particles (smoke). The percentages were 68% in Pará, 70% in Mato Grosso and 70% in Rondônia.
- The study shows a high total expenditure - of almost 1 billion reais - for hospitalizations of low and high severity due to diseases of the respiratory system attributable to exposure to smoke (fine inhalable particles) resulting from wildfires in the Amazon biome.

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#### Average concentration of PM2.5 (2010 – 2020) in micrograms per cubic meter (μg/m<sup>3</sup>)

In 2020, the Covid-19 crisis took on serious dimensions, with most of the states in Amazônia Legal in a precarious situation in terms of medical and hospital care for Covid-19 cases. This study points out that the association of the pandemic situation with wildfires and fires in the Amazon may have aggravated the health situation of the population of Brazil's Legal Amazon. In this context, the main objective of the study was to analyze possible deterioration in the health situation of the population of five Amazonian states due to the pollution emitted by the fires.

For this purpose, the relationship between trends in hospital morbidity (the rate of hospitalizations registered in hospitals) due to respiratory illnesses between 2010 and 2020 and the estimated concentrations of emissions of fine inhalable particles (PM2.5), present in the smoke from wildfires in the same period, investigating the potential health impacts in the states with the highest records of heat sources from fires in the Brazilian Amazon.

### METHOD

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The study included five of the nine states of Brazil's Legal Amazon - Pará, Mato Grosso, Rondônia, Amazonas and Acre, which were chosen because they had the highest number of wildfires recorded in the analyzed period. In order to demonstrate the potential impacts of fires on the health of the populations of these states, the daily rate of hospital morbidity due to respiratory diseases obtained from the Department of Informatics of the Unified Health System (DATASUS), through the Hospital Admission Information System, were analyzed (SIH) and analyzed by day, month and year between January 1, 2010 and October 31, 2020, according to the federation unit of residence. The daily data of hospital admissions were extracted from the \*RD files referring to the AIH (Hospital Admission Authorizations) issued in the Unified Health System (SUS) with the help of the TabWin 4.15 software provided by DATASUS. Hospital admissions for respiratory illnesses related to COVID19 were excluded to calculate the retrospective trend. Therefore, hospital admissions derived from COVID-19 did not enter the set of causes of hospitalizations until December 2019.

This analysis made it possible to calculate, for the chosen period:

i. the relative risks of hospitalization (RR);

ii. the attributable risk of hospitalization in relation to exposure to smoke (to concentrations of particulate matter) (RA);

iii. the excess in hospitalization numbers produced over the analyzed period.

Additionally, information was selected regarding the amount in reais (R\$) spent on low and high complexity hospitalizations (Intensive Care Units - ICU) for respiratory illnesses to estimate the economic health cost of these hospitalizations that could be attributable to the pollution created by to wildfires.

The data for registering hot spots were provided by the wildfire database of the National Institute for Space Research (Inpe). Estimates of the concentration of particulate material (PM2.5) were obtained using satellite data from NASA, with the aerosol optical depth information (AOD) converted by mathematical modeling into PM2.5 concentration estimates and made available for public access by the Copernicus Atmosphere Monitoring Service (CAMS), which is the most recent set of global reanalysis data on atmospheric composition produced by the European Center for Medium-Term Meteorological Forecasts (ECMWF). THE MICROPARTICLES THAT MAKE UP THE SMOKE ARE DEPOSITED IN THE TERMINAL BRONCHI AND IN THE ALVEOLI, AGGRAVATING RESPIRATORY PROBLEMS. THEREFORE, CHRONIC SMOKE EXPOSURE CAUSES INDIVIDUALS MOST VULNERABLE TO COVID-19 TO HAVE MORE SEVERE FORMS OF THE INFECTION.

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### Number of hospitalizations for respiratory system illnesses (2010 – 2019)



### **RESULTS**

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### Hospital morbidity due to diseases of the respiratory system

Between January 2010 and October 2020, 1,252,834 hospital admissions for respiratory illnesses were recorded for all states analyzed. In general, all units of the federation showed a decreasing trend in hospital morbidity rate due to respiratory illnesses from 2010 to 2015, and it stabilized until October 2020. Among those with the highest hospital morbidity rate in the period, the values that stand out the most were from 2010, with Amazonas in the first place (1,051 hospitalizations per 100,000 inhabitants), followed by the states of Pará (898), Acre (852), Mato Grosso (568) and Rondônia (523). The trends included all age groups.

### Relative risk of hospitalization for respiratory illnesses

In total, 3,958 days were analyzed for each of the five states being studied. Among the values of daily hospitalizations found, the averages of the states of Pará (174 daily hospitalizations), Mato Grosso (57) and Amazonas (46) stand out. The maximum limit was raised in the state of Pará, reaching 415 daily hospital admissions - something that can be justified because, in the last 10 years, Pará has led the country in terms of wildfires. When analyzing the estimated

values of daily concentration of PM2.5 for the most critical states of the Amazônia Legal, daily averages were found to be much higher than the acceptable value of PM2.5 in 24 hours (25µg/m<sup>3</sup>), recommended by the WHO. The daily averages of estimated concentration of PM2.5 exceeded the values of 100µg/m<sup>3</sup> (four times higher), with the exception of the state of Acre with an average concentration value of 85µg/m<sup>3</sup>.

## Relative risk of hospitalization for respiratory illnesses in relation to the estimated concentrations of PM2.5

RR values show the probability that an individual exposed to smoke will be hospitalized for respiratory illnesses associated with increased concentrations of particulate material. In general, the RR of hospitalizations in the analyzed areas varies from 1.0 to 1.5, which means that the probability of hospitalization in these states for respiratory illnesses due to high concentrations of PM2.5 can be up to twice as high than individuals exposed to average daily concentrations below 25µg/m<sup>3</sup>.

## Attributable risk of hospitalization for respiratory illnesses in relation to the estimated concentrations of PM2.5

The state of Amazonas was the one with the highest R2 value (coefficient of determination, which explains the percentage of hospitalizations in the period under study), with 87% of hospital admissions for respiratory illnesses in the state attributable to high concentrations of PM2.5. In the state of Pará, hospital admissions for respiratory illnesses attributable to concentrations of PM2.5 represent 68% of hospital admissions for respiratory illnesses. The states of Mato Grosso and Rondônia, on the other hand, presented percentages attributable to the concentrations of the pollutant of 70% and 71%, respectively. It is noteworthy that all percentages are remarkably high and reflect the high estimated average concentrations of PM2.5 in the analyzed states, representing a relevant and worrying risk to human health in these regions.

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### Excessive hospital morbidity due to respiratory diseases attributable to PM2.5 concentrations

In all the States analyzed, the excessive hospitalization due to respiratory illnesses remained constant over time. This pattern can be explained, considering that the exposure to smoke varied little in relation to the values of PM2.5. Although the excessive hospitalization due to respiratory illnesses has remained stable, the data is alarming, considering that these hospital admissions would be preventable if the average daily concentrations of PM2.5 were within the acceptable limits and recommended by the WHO. The highest rates of hospital morbidity attributable to the estimated concentrations of PM2.5 were observed in Rondônia and Pará, followed by Mato Grosso, Amazonas and Acre. It is worth noting that human exposure to smoke (PM2.5 levels) does not have a linear relationship with reference to respiratory diseases. The impact of fires on exposed populations depends on several factors, such as the physiological resilience of exposed individuals, comorbidities, age, location, health conditions at home, biological

vulnerability, weather conditions, concentration of pollutants and their spatial distribution, working conditions, access and quality of health services, and possibly other social factors.

### Economic cost of hospital admissions for respiratory illnesses attributable to PM2.5 concentrations

The total amount spent among the five states analyzed for hospitalizations of low complexity in the SUS due to respiratory illnesses attributable to the increase in air pollution, estimated from the concentrations of PM2.5, adds up to more 774 million reais between 2010 and 2020. These are values that could be saved, since the biggest source of emission of pollutants in the region comes from wildfires, which are often illegal. If we add to the total amount spent on highly complex hospitalizations in the Intensive Care Units (ICU), the total amount spent for the states and the period analyzed we reach a value that exceeds 186 million reais. In other words, the Unified Health System (SUS) paid for a health expenditure of approximately R\$ 1 billion with hospitalizations due to the high concentrations of air pollutants. This amount, wasted on preventable hospitalizations, would be enough to buy about 18 million doses of vaccine against Covid-19, taking into account the amounts paid by the Federal Government in a recent agreement with the company Sinovac.

When analyzing the annual evolution of these costs, it is possible to observe that the States of Pará, Mato Grosso, Amazonas and Rondônia presented the highest amounts spent in the analyzed period. It should also be noted that spending on these hospitalizations increased considerably from 2019 and were boosted in 2020 due to the high demand for hospitalization by Covid-19.



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20.000.000



Costs of hospitalizations attributed to respirable



### RECOMMENDATIONS

- Official health surveillance and monitoring systems need to evolve and require systematic improvements, especially those targeting indigenous populations in the Amazon. The neglect of official records of emergency situations in public health, associated with air pollution generated by wildfires in the Amazon is noteworthy. The preliminary results of this study show an impact on health and loss of quality of life and well-being of the Amazonian populations, with a high economic impact of respiratory diseases for SUS. Exposure to airborne particles is an important risk factor for illness and death from respiratory diseases, with an increase in the overall mortality of individuals with comorbidities, premature deaths, low birth weight (Ortega- Garcia et al, 2018), lung cancer, heart disease, myocardial infarction and stroke (Dong et al 2018; Uzoigwe et al, 2013) and, more recently, type 2 diabetes (Anghorbani et a 2014; Sun & Zhu, 2019), and loss cognitive function. None of these outcomes were analyzed in the context of our study, which leads us to sustain that the high financial cost of the state with hospitalizations of low and high complexity due to diseases of the respiratory system represents a small portion of the health, social and economic impacts resulting from pollution. of air in the Brazilian Amazon.
- Consistent policies to reduce deforestation and fires in the Amazon are critical and immediate. The matter has been the focus of intense global political debates, and the importance of reducing the impacts of the climate crisis has been at the center of it all. This study shows that combating deforestation and degradation of the Amazon biome is fundamental to guarantee basic rights to local populations, such as access to health and a balanced environment. This even reinforces the discourse of the current federal government, albeit shallow and backward, of sovereignty over the Amazon territory.
- It is vital that effective epidemiological and environmental surveillance programs be developed and implemented. The health situation of the Amazonian population exposed to wildfires, especially the most vulnerable groups, such as pregnant women, children, the elderly, and those who have comorbidities, require special attention. The data generated by these programs are crucial for the creation of strategies and the implementation of actions to prevent and mitigate the impacts on the health of the Amazonian populations.
- The emergence of Covid-19 highlights the imminent need for a preventive effort to control zoonoses and that the costs associated with preventive efforts would be substantially lower compared to the economic, social and health costs in controlling potential epidemics and or pandemics. The association between deforestation, wildfires and forest degradation and the emergence and re-emergence of viruses suggests that efforts to maintain forest cover have a high return on investment, and should be a government priority. Exposure to air pollution increases vulnerability and has detrimental effects on the prognosis of patients affected by COVID-19. In the Netherlands, for every 1 µ/m³ (millionth of a gram per cubic meter) of fine particles added to the atmosphere, three more hospitalizations were recorded by Covid-19 (Cole et al. 2020). In the USA, an increase of 1 µg/m3 in PM2.5 is associated with an 8% increase in the Covid-19 hospital morbidity rate (Wu et al., 2020). Considering that in the Amazon, during the dry season, the concentrations of particulate material can reach from 19 to 349 µg/m3, the populations of the region would therefore be subject to higher rates of hospital morbidity in Covid-19.



ecosystems in the Amazon.

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