Surge of respiratory illnesses in children due to fires in Brazil's Amazon region

As thousands of kilometres of forest burned in the Amazon during the months of June through August, the world cried out for the preservation of the largest rainforest in the world. Environmentalists denounced the widespread deforestation of the area, with fires being set in protected areas and even very near indigenous reserves.

According to Brazil's INPE (National Institute for Space Research), the country faced a recorded 72 843 fire outbreaks from Jan 1 to Aug 19, 2019. The number was 83% higher than during the same period last year, when 39 759 fire outbreaks were recorded.

With the alarming rate of fires in the northern region of the country, Brazil's health sector also started to take a closer look at the consequences of the impact of forest fires on humans. A study, coordinated by the Climate and Health Observatory of the Oswaldo Cruz Foundation mapped the effect these fires had on children's health. The study concluded that in the areas most affected by the fire, the number of children hospitalised with respiratory problems during the month of May and June doubled compared with the same numbers for 2018.

According to researchers, in the 100 cities analysed "there were a total of 5091 hospitalisations per month, when the expected value would be 2589 in the fire spot areas. These results suggest an excess of 2500 hospitalisations of children in the municipalities most affected by the burnings". The cities in the study were all located in or surrounding the Amazon, in the states of Pará, Rondônia, Maranhão, and Mato Grosso. In some cities in the southeast areas of Pará, Rondônia, and north of Mato Grosso, the number of hospitalisations were more than five-times higher than normally registered.

The study also concluded that living near one of the thousands of fire spots increased the risk of being hospitalised for respiratory problems by 36%. One of the researchers leading this study, Christovam Barcellos, noted that these numbers are likely to be much higher for the entire year of 2019 due to several factors. According to Barcellos, researchers only gathered data for the months of May and June, when the fires were just starting. Also, he says, the data only comes from the public health system (SUS), with private hospitals and health clinics not included in the findings. "Most worrisome, however, are the number of children who don't have access to the SUS; the [number of] families unable to reach a public hospital. Many people in the region live in small towns, or in indigenous reservations and mining areas, kilometres away from public hospitals and healthcare facilities", noted Barcellos. "Children are more sensitive to external factors, such as pollution, since their immune system and their respiratory system are still under development", says Barcellos. "In the case of the elderly, both their immune system and their respiratory tract are usually compromised. So, these two groups are very vulnerable to pollution from the fires."

According to Eliane Eignotti, professor of epidemiology at the University of the State of Mato Grosso (UNEMAT), more than 90% of the towns in the Amazon region have fewer than 5000 inhabitants. The distance between these small towns and a major urban centre is sometimes days away, down a river, discouraging those who live far from obtaining medical assistance.

Since its creation in 2010, the Observatory has been monitoring the evolution of annual burnings in the Amazon and its effects on the health of populations. But researchers say that this is the first time a study has gathered, in almost real time, such comprehensive information about the correlation between burning and its health effects in the Amazon region.

"Among the pollutants are fine particulate matter, carbon monoxide, nitrogen dioxide, and volatile organic compounds that can worsen heart disease, inflammation of the airways, systemic inflammation and neuro-inflammation, endothelial dysfunction, coagulation, atherosclerosis, alteration of the autonomic nervous system, and damage DNA, with carcinogenic potential", says the report.

Researchers also agree that some of the toxic fumes generated by biomass (forest) burning, or so-called black carbon, are very harmful to the respiratory system, especially for very young and the very old people.

According to the President of the Brazilian Thoracic Society, Jose Miguel Chatkin, these pollutants might remain in the body for months after exposure. "Not only do the particulates remain in the air for months if the weather is dry, the toxic chemicals also remain in the body for an extended period of time." According to Chatkin, mortality rates in Brazil due to respiratory illnesses, such as chronic obstructive pulmonary disease (COPD), cancer, asthma, bronchitis and tuberculosis is significant. "Approximately 10–15% of the Brazilian population has chronic asthma or bronchitis", he says. "In children and the elderly respiratory problems are the most common cause of hospital visits."

"For those children who already have a history of pulmonary infections the costs of breathing the pollutants (from Amazon fires) are high", says

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For more on the **subclinical consequences of fires in the Amazon** see *PLoS One* 2014; **9:** e104177

For more on **what the study found** see *Environ Res* 2012; **117:** 27–35

Chatkin. The pulmonologist, who also coordinates the Pulmonology Service, at São Lucas Hospital (linked to Rio Grande do Sul Catholic University), says the ash from forest burns first irritate the eyes. Upon entering the lung, the particles might cause an inflammatory process. And even when the number of fires in the region start to decrease, the quality of the air remains bad and the concentration of pollutants are still high, says Chatkin. "It is not something that immediately goes away when the burnings stop; it takes weeks to improve air quality and reduce pollutants."

The study took into account that the period of the retrieval of the data was within the annual drought period in the region, coinciding with the decrease in regional rainfall, the decrease in humidity levels, and the period of burning by those wanting to clear land. According to the report during this period the number of cases of respiratory diseases already increases due to the increase in emission of pollutants and the concentration of toxic gases in the atmosphere. "The situation, however, has worsened greatly with the recent burnings. During the peak pollution days, air quality is even worse than some of the more industrial world cities", says the report.

One of the Brazilian states most affected by these annual forest fire cycles is Mato Grosso. According to Eignotti, in 2019, four of every ten fires started in the Amazon forest and around its border were started in Mato Grosso state; specifically around the Xingu Indigenous Preservation area.

Since 2006, Eignotti and other health researchers conduct studies of biomass pollution in the Amazon region. "We measure number of hospitalisations due to respiratory diseases, especially in children and the elderly." "With our research we want to show that what occurred in the big urban centre, in relation to the consequences of atmospheric pollution, also occurs in the forest", she says. Atmospheric pollution research usually focuses on chemicals scattered into the air and those from motor vehicles, but Eignotti and her colleagues have also tried to show that what occurs in the forest also produces pollution which affects the lives of millions.

Deaths and hospitalisations due to respiratory diseases are the most obvious aspects of health problems caused by forest fires, but not the only ones, says Eignotti. "The subclinical consequences (diseases with no immediate or short-term symptoms) are also worrisome", she says.

To study the subclinical consequences of fires in the Amazon, Eignotti and her colleagues led a survey with 309 students, aged 6–15 years old, in three different schools, in three different cities of the Amazon. "We went to one school each year, for three consecutive years (2006–08); and during the second semester of each year registered a daily measure of these schoolkids' pulmonary function", she explains. What they found was an overall reduction in the pulmonary function of these children. "Even those who were presumably healthy in terms of pulmonary tract registered a deterioration of their pulmonary function during that period of time", she says, the result being that "we will have more asthmatic and allergic people in the future due to the air they are breathing today".

Having lived for years in one of the most affected areas of Mato Grosso, Alta Floresta, Eignotti says people living in and around the forest are unaware of the danger these fires can cause to their health. "They complain during a few months that it is bad but then it [ash] goes away and they say it all gets better. What they don't realise is that what they are breathing in might cause them lung cancer in the future."

According to Eignotti, smoke from the fires can rise as high as 2000 to 2500 km up into the atmosphere. High winds, not uncommon in the Amazon region, then spreads these pollutants for thousands of kilometres. "Those who are near are certainly more affected by the cloud of pollutants, but they are not the only ones who suffer", she says. "From Mato Grosso and Para states, this cloud moves west until it hits a physical barrier—which is the Andes Mountain Range", she explains. "The pollutants will then travel south and you have situations like the one we saw in August in São Paulo city", she says alluding to Aug 19, when at 1500 h the city became dark due to what meteorologists say was an air current that brought a giant cloud of smoke from the Amazon region.

Eignotti admits that controlling the fires in the Amazon during burning season is hard, due to political and economic factors. "If we are unable to control the number of fires set in the Amazon, then the health sector has to organise itself to better help those who will feel the full consequences of the fires", she says. "Since we can't reduce the exposure these residents have to the pollutants, we need to set up an arrangement to have more mobile health units and more pulmonologists on hand during the critical months; provide more training to hospital staff and health agents so we can better take care of the population", she concludes.

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