

# Association of Increased Cardiorespiratory Cases with the Mounting Levels of Air Pollution Caused by Fireworks

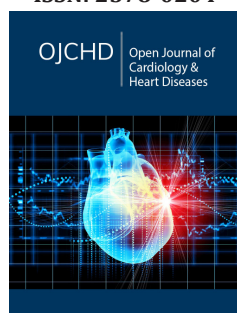
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## Abstract

Air pollution has been identified as a risk factor for cardiovascular morbidity and mortality. Various clinical studies revealed that prominent air pollutants including ground level ozone (O<sub>3</sub>) and Particulate Matter (PM) are strongly linked with increased cardiovascular disease such as Myocardial Infarction (MI), cardiac arrhythmias, ischemic stroke, vascular dysfunction, hypertension, and atherosclerosis. Ozone at the surface level is a strong oxidising agent that induces cardiovascular mortality due to embolism and thrombosis, ischemic heart disease, and stroke. Long-term exposure to PM results in hypertension and increased abdominal adiposity and chronic inflammation which leads to an increased risk of sudden cardiac death, mortality after stroke and heart failure. One of the main events of spontaneous enhancement in air pollution is the coordinated fireworks associated with festivals. Spectacular fireworks displays are the most attractive part of festivals in India and the smoke of which contains toxic air pollutants, fine metallic powders added for colour display, and the secondary air pollutant O<sub>3</sub> in the ambient air. We noticed a pronounced increase in the hospital admission in the Asthma Clinic in a Government hospital in the subsequent days after the intense fireworks during the Vishu festival at Kannur. This paper highlights the susceptibilities of children and elders who are the two groups highly sensitive to the smoke emitted by the fireworks.

**Keywords:** Cardiorespiratory cases; Vishu fireworks; Air pollution; Ozone; PM<sub>2.5</sub>

## Introduction

Air pollution has now emerged as a major environmental threat, which has been identified as a silent killer in the past two decades [1-3]. Further, the strong association between COVID transmission and air quality makes the situation even worse in developing countries [4-8]. Epidemiological studies have demonstrated the strong association between air pollution exposure and increased morbidity and mortality [9-11]. The pronounced increase of prominent air pollutants including carbon mono oxide, Oxides of Nitrogen (NO<sub>x</sub>), ozone (O<sub>3</sub>), Sulphur Dioxide (SO<sub>2</sub>), and Particulate Matter (PM) have severely affected the respiratory vulnerability and much attention has now been focused on the air pollution-induced cardiovascular risk in the past two decades [12-14]. The ambient PM and O<sub>3</sub> have become a major concern for cardiologists and specialists in environmental medicine due to their spontaneous increasing trends during fireworks associated with festivals. This paper highlights the increase in the number of patients registered at the Nodal Centre of the Asthma clinic of the Government hospital in Kannur immediately after the Vishu festival fireworks.

O<sub>3</sub> is a secondary pollutant that is formed by the photolysis of NO<sub>2</sub> by sunlight and its production rate is controlled by the presence of Volatile Organic Compounds (VOC) and excess O<sub>3</sub> is leading to photochemical smog [15-17]. It can affect air quality at local, regional, and even global scales, and it has a detrimental role on the radiative forcing which changes climate and global ecological balance. Moreover, people with a pre-existing history of respiratory diseases

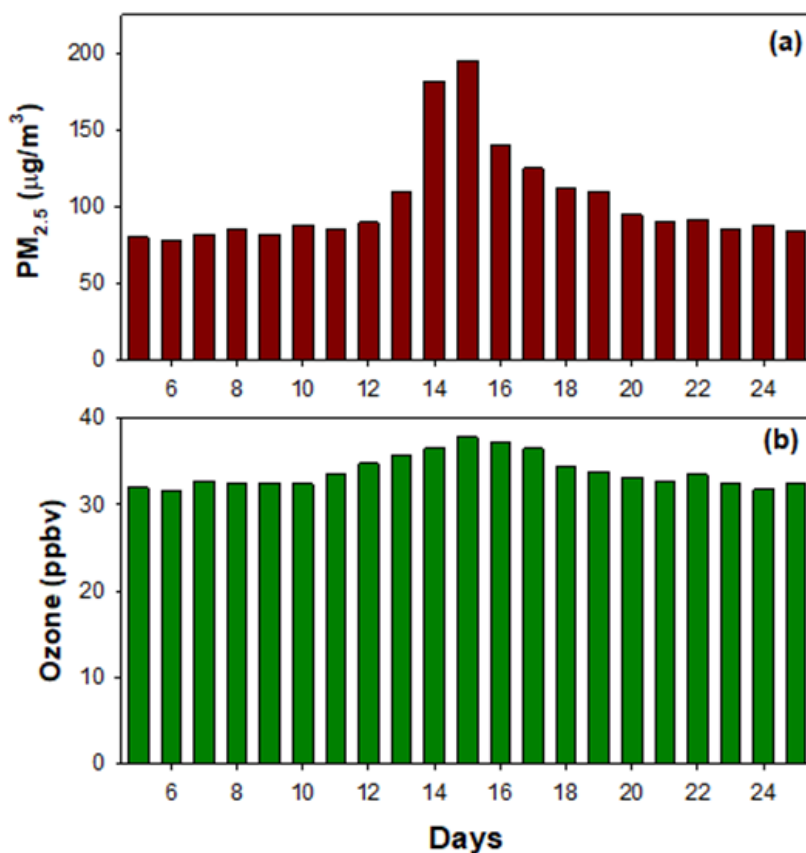
such as asthma and COPD, children, older adults, and active people outdoors (especially outdoor workers) are more vulnerable to ozone exposure. The translocation of PM<sub>2.5</sub> into the bloodstream has damaging effects on the cardiovascular system.

The deposition of PM 2.5 on vascular endothelium can aggravate the local oxidative stress and inflammation, resulting in atherosclerotic plaque instability, and finally may lead to thrombus formation [18]. Long-term exposure to these two prominent trace species in the atmosphere often results in health issues on a large scale but only limited studies have been reported on the spontaneous enhancement of O<sub>3</sub> and PM 2.5 from the fireworks associated with festivals and this needs further investigations [19]. This is an attempt to explore the association between short-term exposure to high-level air pollution environments prevailing during fireworks and the increased number of hospital admissions reported in the Nodal Asthma Clinic in a Government hospital at Kannur, a coastal belt location in India.

## Result and Discussion

The asthma clinic is primarily a network which connects all private hospitals to collect the details of the existing and new cases

of respiratory and cardiology patients. It usually works once in two days to collect the data. We collected data in the month of April 2018 in which Vishu fireworks are usually set on 14 April night and early morning on 15 April. The data were categorized into four age groups to retrieve their susceptibility. Figure 1 shows the increase in O<sub>3</sub> and PM 2.5 during the fireworks which usually start from the evening of April 14 to the morning of April 15 in two spells. Since this night-time fire bursting is mainly celebrated in homes and residential areas, direct inhalation of these two toxic species is much higher, especially by children who used to be quite active in fire cracking. The figure clearly shows the enhancement in O<sub>3</sub> and PM<sub>2.5</sub> during the Vishu day which accounts for the extreme ambient pollution and the details are reported earlier [20]. Figure 2a shows the background cases which indicates the cases already registered and this becomes existing cases while Figure 2b shows the total cases registered each day which comprises existing and new cases registered in the asthma clinic. The observed increase from 10 April accounts for the commencement of fire busting episodes from the first week of April itself. The total cases show a spontaneous increase in the number of cases since the first week of April owing to the gradual transformation towards poor air quality.



**Figure 1:** (a) Daily average variations of PM 2.5 (b) daytime average variations (6 am- 6 pm) of O<sub>3</sub> on Vishu day and control days.

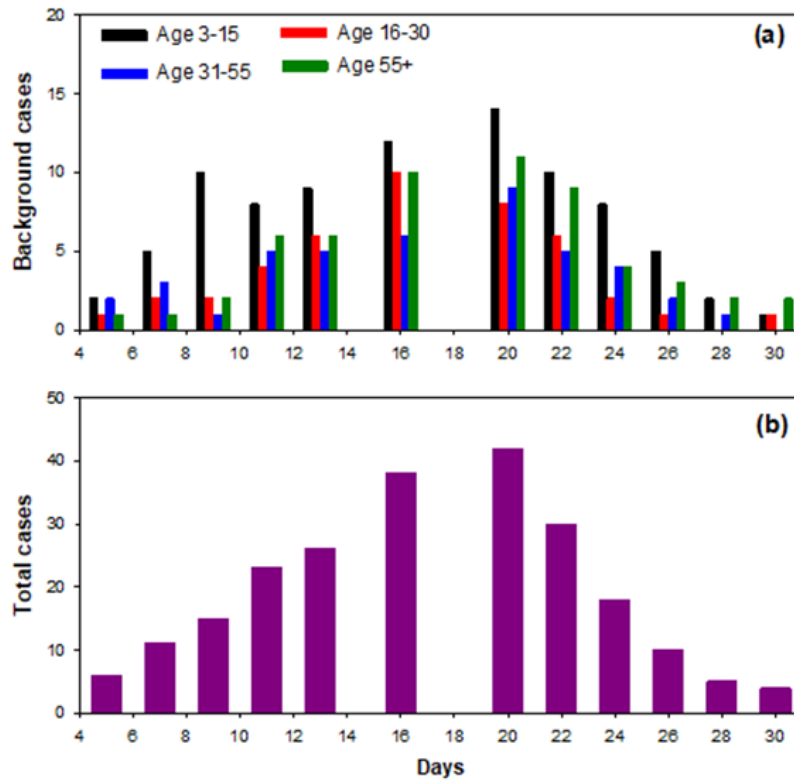


Figure 2: (a) Background cases (b) total cases reported in the Asthma Clinic.

Table 1 shows the categorization of age-wise new registered cases in the month of April. The increase in the number of cases is more pronounced from the first week and it becomes maximum after the fireworks episode. It is noticed that the new cases are found to be increased after the Vishu festival and it is identified that the 3-15 age group is highly sensitive because it is the most enthusiastic group highly exposed to fire bursting right from the

beginning of April. Thus, the inhalation of toxic pollutants at the source itself makes them more susceptible. This study indicates the severity of inhaled toxic species by which the maximum number of new cases were registered on 20 April (nearly 57% of that group and 20% of the total cases on that day) in the 3-15 age group category. The age group 55+ is the largest group which is highly sensitive to the poor air quality induced by fireworks.

Table 1: The number of new cases registered in the month of April for different categories.

Days in April Month	Age Category and the Newly Registered Cases			
	3-15	16-30	31-55	55+
5	0	1	1	1
7	2	0	2	1
9	8	1	0	1
11	5	2	1	3
13	4	3	2	1
16	7	6	4	6
20	8	6	5	7
22	6	3	2	4
24	3	1	1	3
26	1	0	1	1
28	0	0	0	1
30	0	0	0	1

This investigation reveals that the fraction between the new case and existing cases for elders (non-smokers only) is nearly 63% (16% of the total cases) on the same day of 20 April. Elderly people are most likely suffering from chronic diseases, and co-existing chronic lung, heart or circulatory conditions may worsen after exposing them to poor air quality. The increase in new cases registered within a week shows the severe inflammation caused due to the intense fireworks which makes them more susceptible to being infected with cardiological and respiratory illnesses [21]. Since a statistical approach has no relevance to this limited number of the dataset, a model study is required for exploring the science of the impact of air pollution. Besides, a detailed classification is required for categorizing the actual number of cases of COPD, asthma, and other respiratory diseases.

## Conclusion

This work mainly focuses on the increasing trend in cardiorespiratory cases during the fireworks associated with the Vishu festival in Kannur, India. This is only a preliminary attempt, and it needs more classifications of COPD and respiratory cases in detail. Moreover, the specific cause of the illness is required to classify the dominant fraction of the air pollutant for which the patient is more sensitive. These require a detailed analysis with the aid of a model validation which is in progress to identify the health hazards of fireworks being celebrated globally with much enthusiasm.

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