

Effect of Fireworks Pollution on Human Health During Diwali Festival: A Study of Ahmedabad, India

Bharat Dangi¹, Anjali Bhise²

¹Government Physiotherapy College, Civil Hospital Campus, Asarwa, Ahmedabad,

²Principal, Government Physiotherapy College, Civil Hospital, Ahmedabad

Abstract

Context: India has a long tradition of celebrating diwali festival by burning firecrackers. The fireworks release a large amount of air pollutants which have a detrimental effect on human health. Very few studies have done to examine the detrimental effect of fireworks pollution on human health and no scientific study has done in Ahmedabad.

Aims: The aim of the study is to examine the effect of fireworks pollution on human health.

Method: Four residential areas were included in Ahmedabad city. Total 252 people were participated in the study. The structured questionnaire was used to inquire about symptoms like breathlessness, cough, wheeze, runny nose, eye irritation, allergy, itchy skin.

Statistical Analysis Used: Microsoft excel 2010 software was used for analysis.

Results: We found that 48% of subjects complained of cough, 38% of subjects complained runny nose and eye irritation, 27% subjects complained breathlessness, 5% subjects complained allergy and itchy skin and 2% subjects complained wheeze.

Conclusion: The study concludes that there is harmful effect of fireworks pollution on human health and the symptoms of cough, runny nose and eye irritation were most common.

Keywords: *Fireworks pollution, Human health, Diwali.*

Introduction

Diwali festival is celebrated with great joy and enthusiasm in many cities of India including Ahmedabad. It is one of the biggest festivals of India celebrated with decorating home, glowing diyas and burning firecrackers. It is known that firecrackers burning during the festival have a negative impact of air quality index and human health.

Air quality index is affected in many parts of the country in the recent year. In 2014, the World Health Organisation compiled average annual PM 2.5 (particulate matter) numbers for over 1600 cities across the world, including 124 from India. Delhi had the worst air quality in the world by that estimate, Ahmedabad was included in 12 other Indian cities were among the world's worst 20 polluted cities.¹ Of the 13 cities in the

country whose air quality index is measured daily by the central pollution control board, including Ahmedabad, face a severe problem of suspended particulate pollution. The problem is the increasing prevalence of particulate matter of 2.5 microns or less in the city air.² According to the meteorological department, Ahmedabad recorded high levels of sulphur dioxide in the air at 503 micro grams per cubic metre.³

According to new findings of the Global burden of disease report, Outdoor air pollution has become the fifth largest killer in India after high blood pressure, indoor air pollution, tobacco smoking and poor nutrition. Air pollution is the fifth leading cause of death in India, with 620,000 premature deaths in 2010.⁴

During diwali festival, because of fireworks, air quality index is deteriorating. All fireworks contain

carbon and sulphur, which are necessary for burning. In addition, different substances are added (arsenic, manganese, sodium oxalate, aluminium and iron dust powder, potassium perchlorate, strontium nitrate and barium nitrate) to give colour. The burning of fireworks releases a large amount of air pollutants, particularly SO₂ (sulphur dioxide), CO₂ (carbon dioxide), CO (carbon monoxide) and PM along with several metal salts.⁵

Though there are many evidence and data which proved that Ahmedabad was the polluted city and worsening air quality index during diwali festival, no scientific study has been done to examine harmful negative impact of fireworks pollution on human health in Ahmedabad. So, the purpose of the study is to examine the effect of fireworks pollution on human health during diwali festival in Ahmedabad.

Materials and Method

Ethical clearance for the present study was taken from institutional ethics committee. This cross sectional observational study was done in four residential areas of Ahmedabad city namely Chandkheda, Ghatlodiya, L D engineering college and Naroda. Residential areas were selected so as to avoid bias in the study due to the effect of vehicular and industrial pollution. Total 252 subjects participated in the study out of which 141 were male and 111 were female. Age group of subjects was 15-60 years. The subjects having chronic respiratory symptoms,

known respiratory or cardiac disease and active smokers were excluded from the study. The questionnaire was used to inquire about symptoms like breathlessness, cough, wheeze, runny nose, eye irritation, allergy, itchy skin 3 days before diwali, 3 days during diwali.

Results

Table 1 shows total number of subjects complaining particular symptoms. Breathlessness was present in 11 subjects before diwali and 81 subjects after diwali. Cough was present in 2 subjects before diwali and 123 subjects after diwali. Wheeze was present in 7 subjects before diwali and 13 subjects after diwali. Runny nose was present in 13 subjects before diwali and 110 subjects after diwali. Eye irritation was present in 19 subjects before diwali and 116 subjects after diwali. Allergy was present in 1 subject before diwali and 14 subjects after diwali. Nobody complained itchy skin before diwali and 13 subjects complained itchy skin after diwali. Total 70 subjects complained breathlessness, 121 subjects complained cough, 6 subjects complained wheeze, 97 subjects complained runny nose 97 subjects complained eye irritation, 13 subjects complained allergy, 13 subjects complained itchy, which was not present before. Graph 1 shows total number of subjects complaining particular symptoms. It shows cough was most common symptom followed by eye irritation, runny nose, breathlessness, allergy, itchy skin and wheeze.

Table 1: Difference between prevalence of symptoms before and after diwali

Symptoms	Before Diwali (Number of subjects)	During Diwali (Number of subjects)	Difference	Percentage
Breathlessness	11	81	70	27
Cough	2	123	121	48
Wheeze	7	13	6	2
Runny nose	13	110	97	38
Eye irritation	19	116	97	38
Allergy	1	14	13	5
Itchy skin	0	13	13	5

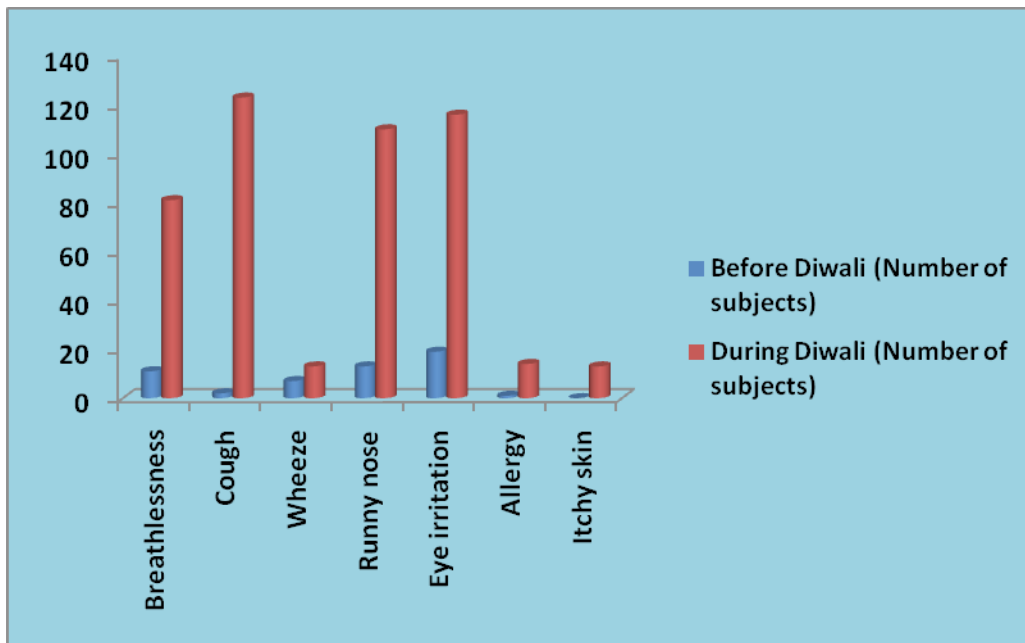


Image 1: Graph showing difference of symptoms before and after diwali

Discussion

The aim of the present study was to know the effect of fireworks pollution on human health, The result of the study shows that 48% of subjects complained cough, 38% of subjects complained runny nose and eye irritation, 27% of subjects complained breathlessness, 5% of subjects complained allergy and itchy skin and 2% of subjects complained wheeze which was not present before diwali.

There are many studies which proved that pollutions in ambient air are increase during fireworks. Chichilin found that Outdoor ambient PM levels increase significantly during fireworks and fire crackers burning. Fireworks PM remains suspended in the air for up to 1 month after festival displays, causing high PM concentrations for a long period.⁶ Jayantnirmalkar et al found that during diwali festival PM10 concentration was about 2.6 and 1.9 times higher than pre-diwali and post-diwali period, respectively in eastern central India. PM2.5 and PM1 concentrations during diwali festival were more than 2 times higher than pre-diwali and post-diwali.⁷ Venkata Swamy Yerramsetti et al found that because of fireworks burning, there is twofold to threefold increase level of ozone, nitrogen oxides and black carbon concentrations during diwali festival in Hyderabad.⁸

There are some studies which showed health effects of fireworks. Raghu et al found that the numbers of hospital admissions post-diwali were significantly more compared to pre-Diwali from both rural and urban locations in south India. The mean duration of hospital stay was significantly less pre-Diwali compared to post-Diwali. Post diwali, significantly increased number of patients required ventilator support.⁹ A case of acute eosinophilic pneumonia was presented in hospital after inhaling smoke from fireworks for 3 consecutive nights.¹⁰ Shantanusharma et al found that the prevalence of post diwali morbidity was increased in Delhi.¹¹

Smith et al found that fireworks air pollution in Honolulu can alter pulmonary function in susceptible people. They also speculated that the 26% decrease in maximal midexpiratory flow rate in susceptible people and 4.7% decrease in maximal midexpiratory flow rate in normal subjects.¹² Gouder C et al did extensive medline search and found that strong evidence of the impact of fireworks on respiratory health is lacking in susceptible as well as healthy individuals with no formal studies on COPD (chronic obstructive pulmonary disease) or asthma. They suggest susceptible individuals, mainly patients suffering from respiratory conditions, should avoid heavy exposure so as to avoid the possibility of exacerbations of their illness. Increasing awareness amongst the high-risk groups should decrease morbidity

and the number of unscheduled health care visits and hospitalizations.¹³

Firework composition and pollutants: The firework is a mixture of substances designed to produce an effect by heat, light, sound, gas and smoke. The five basic ingredients in fireworks are fuel, an oxidiser, colourants, binder and chloride donor. The mixture of sulphur, charcoal and potassium nitrate used as fuel. An oxidisers in fireworks are perchlorates, chlorates and nitrates. The metals like aluminium, barium, carbon, calcium salts, chloride compounds, copper, iron, lithium, magnesium, sodium compounds, sulphur, antimony, titanium and zinc are added in fireworks to produce different colours during burning.¹⁴

The burning of fireworks releases large amount of sulphur dioxide, nitrogen oxide, carbon monoxide, several metals and particulate matter into the air. SO₂ is a highly irritating, colourless soluble gas. SO₂ is a major air pollutant and has significant impacts upon human health. Inhaling SO₂ is associated with increase respiratory symptoms and disease and difficulty in breathing. Short-term exposures to the NO₂ gas may cause airway responsiveness and lung function injury. Long-term exposures may reduce immunity and lead to respiratory infections.¹⁵ CO is an odorless, colourless and tasteless but dangerous gas. Breathing low levels of CO can cause headache, nausea, dizziness, weakness, confusion, disorientation. PM can be both a primary and a secondary air pollutant. Particles having an aerodynamic diameter of <10 µm are called PM10 and those <2.5 µm are called PM2.5. Particles <1 µm in diameter are called ultrafine particles (UFP) or nanoparticles. Particles in these size ranges can easily enter into the distal portions of the lung and the systemic circulation.¹⁶

Potential mechanism of health effects: The potential mechanisms linking air pollution involve direct effects of pollutants on the cardiovascular system, blood and lung receptors and indirect effects mediated through pulmonary oxidative stress and inflammatory responses. Direct effects may occur via agents that readily cross the pulmonary epithelium into the circulation, such as gases and possibly UFP along with soluble constituents of PM2.5.¹⁷⁻¹⁸ Less acute and chronic indirect effects may occur via pulmonary oxidative stress/inflammation induced by inhaled pollutants. The harmful effects of ambient air pollutants are caused by the formation of reactive oxygen species, which in turn induce oxidative stress in the lungs inciting a powerful cellular and

mediator inflammatory response that spills into the systemic circulation and causes harmful effects in other body organs.¹⁹

There are some limitations of the study. The composition of firecrackers was not analysed. The air quality index of the study areas was not measured due to unavailability of the measuring instrument. Apart from inquiry about respiratory symptoms, other investigations like pulmonary function test and chest x-ray was not performed. The effect of firecrackers composition on fireworks manufacture was also not known. Future study by measuring the air quality index and performing spirometry can be done to know the acute effect of fireworks pollution exposure on pulmonary health.

Conclusion

The study shows that exposed person develops symptoms like breathlessness, cough, running nose, eye irritation, allergy and itchy skin that due to acute exposure of fireworks pollutants. The quality of firecrackers should be checked before they are sold in the market and use of harmful chemicals and metals for firecrackers manufacture should be banned. Implementation of strict air quality index standard during diwali festival should be formed by government and must be followed. Awareness must be created in public regarding potential harmful effect of air pollutions.

Acknowledgement: We would like to thank all the subjects for active participation in the study without whom study could not be possible. Our sincere thanks to Dr. Nikunj Kotwal, Dr Anushree Dabhowale and Dr Setoo Jain for their immense help in data collection.

Conflict of Interest: Nil

Source of Funding: Nil

Ethical Clearance: Nil

References

1. Ambient (outdoor) air pollution in cities database 2014. Available from: http://www.who.int/phe/health_topics/outdoorair/databases/cities/en [Last accessed on 2015 december 3].
2. Ahmedabad air judged among most dusty in the country. Available from: <http://timesofindia.indiatimes.com/home/environment/pollution/Ahmedabad-air-judged-among-most-dusty-in-the->

- country/articleshow/48893201. [Last assessed on 2015 december 11].
3. India celebrates a not so swacchdiwali, air pollution soars across the country. Available from: <http://www.businessinsider.in/44922615> [Last assessed on 2015 december 11].
 4. Air pollution is now the fifth largest killer in India, says newly released findings of Global Burden of Disease report. Available from: <http://cseindia.org/content/air-pollution-now-fifth-largest-killer-india-says-newly-released-findings-global-burden-disease>. [Last assessed on 2015 december 11].
 5. Limaye S, Salvi S. Ambient air pollution and the lungs: What do clinicians need to know? *Breathe* 2010;6:234-44.
 6. Chi-Chi Lin. A review of the impact of fireworks on particulate matter in ambient air. *Journal of the Air & Waste Management Association* 2016;66:1171-82.
 7. Nirmalkar J, Deb MK, Deshmukh DK, Verma SK. Mass Loading of Size-Segregated Atmospheric Aerosols in the Ambient Air During Fireworks Episodes in Eastern Central India. *Bull Environ Contam Toxicol* 2013;90:434-9.
 8. Yerramsetti VS, Sharma AR, Navlur NG, Rapolu V, Dhulipala NSK, Sinha PR. The impact assessment of Diwali fireworks emissions on the air quality of a tropical urban site, Hyderabad, India, during three consecutive years. *Environmental Monitoring and assessment* 2013;185:7309-25.
 9. Raghu BP, Swaroop HS, Chakraborty A. Hospitalizations due to respiratory problems during diwali festival in a tertiary care hospital in South India. *J. Evid. Based Med. Healthc.* 2016; 3:635-37.
 10. Hirai K, Yamazaki Y, Okada K, Furuta S, Kubo K. Acute eosinophilic pneumonia associated with smoke from fireworks. *Intern Med* 2000;39:401-3.11. Sharma S, Nayak H, Lal P. Post-Diwali morbidity survey in a resettlement colony of Delhi. *Indian J Burns* 2015;23:76-80.
 12. Smith, M.R. and V.D. Dinh. Changes in forced expiratory flow due to air pollution from fireworks. Preliminary report. *Environ Res* 1975;9:321-31.
 13. Gouder C, Montefort S. Potential impact of fireworks on respiratory health. *Lung India* 2014;31:375-9
 14. Shallcross D, Harrison T. Smoke is in the air: how fireworks affect air quality. *Science in school* 2011;21:47-51.
 15. Han X, Naeher LP. A review of traffic-related air pollution exposure assessment studies in the developing world. *Environment International* 2006;32:106-20.
 16. Johnson RL. Relative effects of air pollution on lungs and heart. *Circulation* 2004;109:5-7.
 17. Nemmar A, Vanbilloen H, Hoylaerts MF, et al. Passage of intratracheally instilled ultrafine particles from the lung into the systemic circulation in hamster. *Am J Respir Crit Care Med* 2001;164:1665-68.
 18. Nemmar A, Hoet PH, Vanquickenborne B, et al. Passage of inhaled particles into the blood circulation in humans. *Circulation* 2002;105:411-14.
 19. Kelly FJ. Oxidative stress and its role in air pollution and adverse health effects. *Occupational and environmental medicine* 2003; 60:612-16.