www.jmscr.igmpublication.org
Impact Factor 5.84
Index Copernicus Value: 83.27
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v5i7.05

IGM Publication
Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Effects of Air Pollution on Respiratory Diseases in India

Authors
Rekha Jalandra[1], Archana Joon[2]
[1]Assistant Professor, Hindu Girls College, Sonepat, Haryana, India
Email: *rekhajalandra7@gmail.com*
[2]Former M. Sc Student, MDU Rohtak, Haryana, India
Email: *archnajoon789@gmail.com*

Abstract
Air pollution is the undesirable change in quality of air. In a developing country like India where majority of population lives in rural area, but both rural and urban areas are equally affected by pollution. Air pollution is largest environmental health risk that approximately kills 1 in 8 people globally, due to heart disease, stroke, respiratory disease and cancer. According to WHO air quality model (2016) about 92 % of world's population lives in places where air quality level exceed WHO limits. Particulate matter present in polluted air such as dust, smoke, pollen and volatile organic compounds trigger can cause serious damage to respiratory tract. When we breathe in dirty air, we bring air pollutants deep into our lungs; can trigger new cases of asthma. It can not only worsen a pre-existing respiratory illness, but also provoke the development of other diseases such as chronic illness, including chronic obstructive pulmonary disease, asthma and respiratory allergies, pulmonary hypertension, lung cancer etc., which can be fatal. By eating balanced and nutritious diet, not exposing to polluted area and wearing masks at a place where AQI is above the limit. Creating awareness about harmful effects of air pollution among people may be helpful to downscale its fatal effects.
Keywords- *Pollution, indoor, outdoor, AQI, biomass, particulate matter.*

Introduction

Air pollution is responsible for many health problems majorly in urban but also in some rural cities in India. According to WHO (World Health Organization) pollution is contamination of environment by any chemical, physical or biological agents that modifies the natural characteristics of atmosphere. Air pollution can be categorized into two categories, indoor and outdoor pollution which are presence of pollutants in air inside and outside the house respectively. Indoor cooking and heating with biomass fuels (agricultural residues, dung, straw and wood) or coal produces high levels of smoke that contains a various health-damaging pollutants. According to WHO Indoor air pollution is responsible for 2 million deaths annually. Outdoor air pollution is the result of inefficient combustion of fuels for transport, power generation and other activities. The World Health Organization (WHO) estimated 84000 deaths directly attributable to outdoor air pollution in Indian cities. Urban outdoor air pollution is estimated to cause 1.3 million deaths worldwide per year (WHO report on air pollution). Global urbanization which requires

large energy consumption has resulted in increased emissions into the atmosphere and a decrease in urban air quality [1]. Pollutants can be classified as primary or secondary. Primary pollutants are released directly into the atmosphere, whereas secondary pollutants result from chemical reactions among primary pollutants [2]. The air pollutants of most concern include nitrogen dioxide (NO_2), ozone and particulate matter (PM) [1]. PM is a general term that refers to a complex mixture of solids or liquids that vary in number, size, shape, surface area, chemical composition, solubility depending upon its place of production and mode of emission [3]. Particulate matter include inorganic compounds such as sulphates, nitrates, organic compounds such as polycyclic aromatic compounds and biological materials, such as pollen, bacteria, spores, and animal remains. On the basis of total suspended particle size, PM is classified as follows: constituent particles of up to 30 µm in diameter; constituent particles of less than 10 µm in diameter (PM_{10} or inhalable fraction); constituent particles of less than 2.5 µm in diameter ($PM_{2.5}$ or fine PM); and constituent particles of less than 10 nm in diameter ($PM_{0.1}$ or ultrafine PM) [4,5]. Current studies revealed a potential association between urban air pollutants and adverse health effects, particularly those that affect the respiratory and cardio-vascular systems [6,7].

Mechanism: How Air Pollution Affect the Respiratory System

Several mechanisms have been suggested to explain the adverse effects of air pollutants. Most widely accepted explanation is that, once in contact with the respiratory epithelium, high concentrations of oxidants and pro-oxidants in environmental pollutants such as PM of various sizes and compositions and in gases such as O_3 and nitrogen oxides cause the formation of oxygen and nitrogen free radicals. These pollutants in turn induce oxidative stress in the airways. These free radicals are neutralized by antioxidants such as vitamin C. In other words, an increase in free radicals that are not neutralized by antioxidant defenses initiates an inflammatory response with release of inflammatory cells and mediators (cytokines, chemokines, and adhesion molecules) that reach the systemic circulation, leading to inflammation, which not only has a negative effect on the respiratory system but also causes systemic effects [4,5]. Air pollutants also negatively and significantly harm lung development, creating an additional risk factor for developing lung diseases later in life.

a. Latent Period

The effects of pollutants on health can be acute or chronic. Acute effects are manifest shortly after exposure (hours or days). Chronic effects are usually assessed in longitudinal studies over years or decades [8].

b. Effects of Air Pollution on Children

Children are highly susceptible group to air pollutants. Children are more susceptile than adults because children have higher basal metabolic rates and engage in more physical activity than do adults, as well as because children spend more time outdoors than do adults. Also the volume of air passing through the airways of a child at rest is twice that of an adult under similar conditions. Pollutant-induced irritation producing a weak response in adults can result in significant obstruction in children. In addition, the fact that their immune system is not fully developed increases the possibility of respiratory infections [4,5,8-10].

c. Effects of Air Pollution during Pregnancy

During pregnancy exposure to air pollutants can impair foetal development and cause intrauterine growth retardation, premature birth, low birth weight, congenital anomalies, and, in cases that are more severe, intrauterine or prenatal death [11]. Maternal inhalation of pollutants can cause accelerated cell proliferation, prematurity and change in metabolism of foetus [12,13]. Another study revealed that a 1-µg/m3 increase in PM10 concentration and a 1-ppm increase in CO concentration were associated with a 0.6g and a 12g reduction in birth weight, respectively [14,15].

Diseases of Respiratory System

Asthma

Asthma, a chronic disease of the lungs characterized by inflammation and narrowing of the airways, causes a sensation of tightness in the chest, shortness of breath, wheezing, and coughing. If untreated, asthma episodes can be near fatal or even fatal [16]. For the past 40 years, the prevalence of asthma has increased in all countries in parallel with that of allergy. Asthma is still increasing worldwide as communities adopt modern lifestyles and become urbanized [13,53,54]. According to the WHO data published in may 2014 Asthma Deaths in India reached 151, 877 or 1.71% of total deaths. The age adjusted Death Rate is 17.16 per 100,000 of population ranks India #14 in the world. In a study among children between 6-18 years of age revealed that there is a significant association between traffic-related pollution and the development of asthma exacerbations and respiratory infections in children born to atopic parents and in those suffering from recurrent wheezing or asthma. These findings suggest that environmental control may be crucial for respiratory health in children with underlying respiratory disease [17]. The recent data base on asthma and traffic is less robust in adults [18]. A recent advance in assessing the effects of air pollution on asthma is the use of biomarkers of airway inflammation and oxidative stress as outcome measures in epidemiological studies [19-21]. With a projected increase in the proportion of the world's population living in urban areas, there is likely to be a marked increase in the number of people with asthma worldwide over the next two decades. Asthma affects approximately 300 million people worldwide. The costs of asthma are high in severe or uncontrolled asthma [22].

Chronic Obstructive Pulmonary Disease (COPD)

COPD is a progressive disease that makes it hard to breathe. Its symptoms include coughing that produce large amount of mucus, wheezing, shortness of breath and chest tightness. Among various causes of COPD, cigarette smoking is the leading one [23,24]. Chronic exposure to particulate pollutants may cause impaired lung growth in children. In a study of elderly people (≥65 years), it was found that short-term increases in O3 and PM10 concentrations were related to increased hospital admissions for COPD and pneumonia, especially during the warm season [25]. And it may be possible that the magnitude of effect increases with the days of exposure. In a multi-centric study in India, prevalence of COPD (chronic obstructive pulmonary disease) was 4.1%, with a male to female ratio of 1.56:1 and a smoker to non-smoker ratio of 2.65:1 in urban and the rural populations at Bangalore, Chandigarh, Delhi and Kanpur [26,27]. Particulate matter from fossil fuel combustion is air pollutants which can cause inflammation in the lung and further impaired the reduced pulmonary function in COPD patients [28]. Infection is one of the major factors which worsen COPD. In India, a study collecting data without spirometry assessment suggested that 12 million people were affected by COPD [29].

Lung Cancer

Lung cancer causes more deaths worldwide than any other cancer, with 1·8 million new cases and 1·5 million deaths in 2012. It is the most diagnosed cancer in men and third most common in women after breast and colorectal cancers [30]. Partial combustion of solid fuel produces large amount of particulate matter and carcinogenic gases. Epidemiologic studies have revealed that general air pollution, mainly due to the by-products of the incomplete combustion of fossil fuels, is associated with small relative increases in lung cancer. According to the WHO data published in Geneva in may 2014 Lung Disease Deaths in India reached 1,061,863 or 11.97% of total deaths. The age adjusted Death Rate is 126.99 per 100,000 of population ranks India #1 in the world. Lung cancer is often and accurately related to smoking. Smoking itself is one of the sources of air pollution in a closed space such as a room, besides its pathogenic role in the pathogenesis of COPD [31]. In smokers with asthma, lung function can be improved by

smoking cessation [32]. Inhalation exposure to airborne particulate matter in fine ranges ($PM_{2.5}$) is related to pulmonary dysfunction. In another study it was observed that each 10 μg/m3 elevation in fine particulate air pollution was associated with approximately 4%, 6%, and 8% increased risk of cardiopulmonary and lung cancer mortality respectively [33].

Low Vitamin D Status

Air pollution may have an indirect negative impact on vitamin D status. Vitamin D is majorly synthesized in the skin through the action of sunlight since vitamin D is found naturally only in a few food items [34]. Therefore, vitamin D status in humans is mainly determined by exposure to ultraviolet B (UVB) radiation, which initiates the conversion of 7-dehydrocholesterol to vitamin D3 [35]. Air pollution decreases the amount of sunlight that reaches the earth surface. According to a study, to reach an optimal vitamin D status in urban residents, the index of sun exposure was double that for rural residents [36]. This suggests that, in an urban environment, the amount of UVB reaching the earth is significantly decreased due to air pollution, which is the major factor in high prevalence of vitamin D deficiency. Deficiency of Vitamin D can promote multiple diseases, particularly osteoporosis but also cardiovascular disease, diabetes and cancer [37,38].

Measures to Reduce Negative Impact of Air Pollution

a. Nutritional solutions

Air pollution has been found to be associated with many fatal diseases both in urban and rural areas. In urban areas pollution is mainly due to industries, factories and TRAP (Traffic Related Air Pollution). Whereas, in rural areas it is due to household air pollution (HAP), burning of biomass and solid fuels. Diets characterized by a low intake of fruit, vegetables, wholegrain and fish, and an increased intake of processed foods, resulting in a nutrient intake that is low in beneficial nutrients such as antioxidants (e.g., carotenoids, vitamin D, E, falvinoids) and omega-3 PUFA [38,39]. This reduces immunity against harmful effects of air pollution. It has been hypothesized that the intake of anti-oxidant and anti-inflammatory nutrients may improve various respiratory effects of air pollution through reductions in oxidative stress and inflammation [40]. Pollutants in air increase the production of reactive oxygen species (ROS) which in turn react with organic molecules and destroy them. Omega-3 PUFA intake from fish oil increases the activity of endogenous antioxidants which destroy excess of free radicals and reduce oxidative stress [41,42].

b. Preventive Measures

In a developing country like India, one of the major sources of rural pollution is household air pollution from cooking and heating practices. Clean LPG and electricity can be used as alternative to reduce pollution. People can reduce the time spent on outdoor activity when level of Air Quality Index [AQI] is beyond specified level [43]. Wearing personal protective equipment might be a useful for avoiding detrimental effect of ambient air pollutants [44]. Masks have been proved to be useful in reducing respiratory virus transmission [45]. Using of nose mask during haze environment can help people to prevent adverse effects from vehicular pollution [46].

Conclusion

India is a developing country which is progressing towards being developed. With the great progression one negative thing that is increasing along with is air pollution. Air pollution can create various diseases like asthma, COPD, lung cancer etc. one should try to reduce or compensate this by a positive thing like growing trees, by being less exposed to highly polluted places. A prudent diet is a key determinant to health throughout the whole life and could reduce the deleterious impact of air pollution on health. WHO launched The Global Alliance against Chronic Respiratory Diseases (GARD) is a voluntary alliance of national and international organizations, institutions and agencies committed to the vision of "a world where all people breathe freely". Incorporating the 'universal

access to clean fuel' agenda within the broader framework of rural development and raising the standard of living will go a long way in reducing disease burden.

.

Abbreviations

COPD: Chronic Obstructive Pulmonary Disease
TRAP: Traffic Related Air Pollution
PM: Particulate Matter
AQI: Air Quality Index
ROS: Reactive Oxygen Species

References

1. Kelly FJ, Influence of air pollution on respiratory disease, UK, EMJ. 2014, 2:96-103.
2. Arbex MA, Santos UD, Martins LC, Nascimento Saldiva PH, Amador Pereira LA and Braga AL, Air pollution and the respiratory system, J. bras. Pneumol. 2012, 38:643-55.
3. Kelly FJ and Fussell JC, Size, Source and chemical composition as determinants of toxicity attributable to ambient particulate matter, Atmospheric Environ. 2012, 60:504-26.
4. Künzli N, Perez L and Rapp R, Air quality and health, Lausanne (Switzerland): European Respiratory Society, World Health Organization. 2010, p. 89.
5. World Health Organization, Air quality guidelines, Global update 2005, Particulate matter, ozone, nitrogen dioxide and sulfur dioxide. Copenhagen: World Health Organization. 2005.
6. Schwartz J, Air pollution and children's health, Pediatrics. 2004, 113: 1037-43.
7. Trasande L and Thurston GD, The role of air pollution in asthma and other pediatric morbidities, J Allergy Clin Immunol. 2005, 115: 689-99.
8. Braga AL, Zanobetti A and Schwartz J, The lag structure between particulate air pollution and respiratory and cardiovascular deaths in 10 US cities, J Occup Environ Med. 2001, 43:927-33.
9. Salvi S, Health effects of ambient air pollution in children, Paediatr Respir Rev. 2007, 8:275-80.
10. Minelli C, Wei I, Sagoo G, Jarvis D, Shaheen S and Burney P, Interactive effects of antioxidant genes and air pollution on respiratory function and airway disease: a HuGE review, Am J Epidemiol. 2011, 173:603-20.
11. Srám RJ, Binková B, Dejmek J and Bobak M, Ambient air pollution and pregnancy outcomes: a review of the literature, Environ Health Perspect. 2005, 113:375-82.
12. Ritz B and Wilhelm M, Ambient air pollution and adverse birth outcomes: methodologic issues in an emerging field, Basic Clin Pharmacol Toxicol. 2008, 102:182-90.
13. Kannan S, Misra DP, Dvonch JT and Krishnakumar A, Exposures to airborne particulate matter and adverse perinatal outcomes: a biologically plausible mechanistic framework for exploring potential effect modification by nutrition, Environ Health Perspect. 2006, 114:1636-42.
14. Lacasaña M, Esplugues A and Ballester F, Exposure to ambient air pollution and prenatal and early childhood health effects, Eur J Epidemiol. 2005, 20:183-99.
15. Medeiros A and Gouveia N, Relationship between low birthweight and air pollution in the city of Sao Paulo, Brazil, Rev Saude Publica. 2005, 39:965-72.
16. Samoli E, Nastos PT, Paliatsos AG, Katsouyanni K and Priftis KN, Acute effects of air pollution on pediatric asthma exacerbation: evidence of association and effect modification, Environ Res. 2011, 111:418-24.
17. Esposito S, Galeone C, Lelii M, Longhi B, Ascolese B, Senatore L, Prada E, Montinaro V, Malerba S, Patria MF and Principi N,

Impact of air pollution on respiratory diseases in children with recurrent wheezing or asthma, BMC Pulm Med. 2014, 14:130.

18. Laumbach RJ and Kipen HM, Respiratory Health Effects of Air Pollution: Update on Biomass Smoke and Traffic Pollution, J Allergy Clin Immunol. 2012, 129: 3-13.
19. McCreanor J, Cullinan P, Nieuwenhuijsen MJ, Stewart-Evans J, Malliarou E, Jarup L, Harrington R, Svartengren M, Han IK, Ohman-Strickland P, Chung KF and Zhang J, Respiratory effects of exposure to diesel traffic in persons with asthma, N Engl J Med. 2007, 357:2348-58.
20. Romieu I, Albino BV, Consuelo EN, Ann-Charlotte A, David DS, Peter DS and Anna C, Exhaled breath malondialdehyde as a marker of effect of exposure to air pollution in children with asthma, J Allergy Clin Immunol. 2008, 121:903–9.
21. Romieu I, Castro-Giner F, Kunzli N and Sunyer J, Air Pollution, Oxidative Stress and Dietary Supplementation: A Review. Eur. Respir. J. 2008, 31:179–197.
22. Masoli M, Fabian D, Holt S and Beasley R, Global Initiative for Asthma (Gina) Program. The Global Burden of Asthma: Executive Summary of the Gina Dissemination Committee Report, Allergy. 2004, 59:469–478.
23. Chen H, Goldberg MS and Villeneuve PJ, A systematic review of the relation between long-term exposure to ambient air pollution and chronic diseases, Rev Environ Health. 2008, 23: 243-297.
24. Oberg M, Jaakkola MS, Woodward A, Peruga A and Prüss-Ustün A, Worldwide burden of disease from exposure to second-hand smoke: a retrospective analysis of data from 192 countries, Lancet. 2011, 377:139-46.
25. Medina-Ramón M, Zanobetti A and Schwartz J, The effect of ozone and PM10 on hospital admissions for pneumonia and chronic obstructive pulmonary disease: a national multicity study, Am J Epidemiol. 2006, 163:579-88.
26. Jindal SK, Aggarwal AN, Chaudhry K, Chhabra SK, D'Souza GA, Gupta D, Katiyar SK, Kumar R, Shah B and Vijayan VK, Asthma Epidemiology Study Group. A multicentric study on epidemiology of chronic obstructive pulmonary disease and its relationship with tobacco smoking and environmental tobacco smoke exposure, Indian J Chest Dis Allied Sci. 2006, 48:23-29.
27. Rumana HS, Sharma RC, Beniwal V and Sharma AK, A retrospective approach to assess human health risks associated with growing air pollution in urbanized area of Thar Desert, western Rajasthan, India J Environ Health Sci Eng. 2014, 12: 23.
28. Abbey DE, Burchette RJ, Knutsen SF, Mcdonnell WF , Lebowitz MD and Enright PL, Long-term particulate and other air pollutants and lung function in nonsmokers, Am J Respir Crit Care Med. 1998, 158:289-98.
29. Ko FW and Hui DS, Air Pollution and Chronic Obstructive Pulmonary Disease, Respirology. 2012, 17:395-401.
30. Ferlay J, Soerjomataram I and Ervik M, Globocan 2012 v1.0, Cancer incidence and mortality worldwide, IARC CancerBase No. 11. 2013, Accessed June 19, 2015.
31. Jiang XQ, Mei XD and Feng D, Air pollution and chronic airway diseases: what should people know and do?, J Thorac Dis. 2016, 8:31-40.
32. Chaudhuri R, Livingston E, McMahon AD, Lafferty J , Fraser I, Spears M, Charles P, McSharry and Thomson NC, Effects of smoking cessation on lung function and airway inflammation in smokers with asthma, Am J Respir Crit Care Med. 2006, 174:127-33.
33. Pope CA III, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K and Thurston GD, Lung cancer, cardiopulmonary mortality,

and long-term exposure to fine particulate air pollution, J Amer Med Assoc. 2002, 287:1132-41.

34. Teotia SPS and Teotia M, Endemic bone disease and deformities consequent to disorders in nutrition, bone and mineral metabolism and related hormones. Published report, New Delhi: Indian Council of Medical Research. 1996, p. 1-111.
35. Péter S, Holguin F, Wood LG, Clougherty JE, Raederstorff D, Antal M, Weber P and Eggersdorfer M, Nutritional solutions to Reduce Risks of Negative Health Impacts of Air Pollution, Nutrients. 2015, 7: 10398-416.
36. Manicourt DH and Devogelaer JP, Urban Tropospheric Ozone Increases the Prevalence of Vitamin D Deficiency Among Belgian Postmenopausal Women with Outdoor Activities During Summer, J Clin Endocrinol Metab. 2008, 93:3893-99.
37. Holick MF, Vitamin D Deficiency in 2010: Health Benefits of Vitain D and Sunlight: A D-Bate, Nat Rev Endocrinol. 2011, 7:73-75.
38. Troesch B, Hoeft B, Mcburney M, Eggersdorfer M and Weber P, Dietary Surveys Indicate Vitamin Intakes Below Recommendations Are Common in Representative Western Countries, Br J Nutr. 2012, 108:692-98.
39. Wood LG, Garg ML, Simpson JL, Mori TA, Croft KD and Wark PA, Gibson P.G. Induced Sputum 8-Isoprostane Concentrations in Inflammatory Airway Diseases, Am J Respir Crit Care Med. 2005, 171:426-30.
40. Kelly FJ, Dietary Antioxidants and Environmental Stress, Proc Nutr Soc. 2004, 63:579–85.
41. Romieu I, Garcia-Esteban R, Sunyer J, Rios C, Alcaraz-Zubeldia M, Velasco SR and Holguin F, The Effect of Supplementation with Omega-3 Polyunsaturated Fatty Acids on Markers of Oxidative Stress in Elderly Exposed to Pm (2.5) Environ Health Perspect. 2008, 116:1237–42.
42. Tong H, Rappold AG, Diaz-Sanchez D, Steck SE, Berntsen J, Cascio WE, Devlin RB and Samet JM, Omega-3 Fatty Acid Supplementation Appears to Attenuate Particulate Air Pollution-Induced Cardiac Effects and Lipid Changes in Healthy Middle-Aged Adults, Environ Health Perspect. 2012, 120:952-57.
43. Barn P, Larson T, Noullett M, Kennedy S, Copes R and Brauer M, Infiltration of forest fire and residential wood smoke: an evaluation of air cleaner effectiveness, J Expo Sci Environ Epidemiol. 2008, 18:503-11.
44. Zhao P, Yu KP and Lin CC, Risk assessment of inhalation exposure to polycyclic aromatic hydrocarbons in Taiwanese workers at night markets, Int Arch Occup Environ Health. 2011, 84:231-37
45. MacIntyre CR, Cauchemez S, Dwyer DE, Seale H, Cheung P, Browne G, Fasher M, Wood J, Gao Z and Booy R, Ferguson N, Face Mask Use and Control of Respiratory Virus Transmission in Households, Emerg Infect Dis. 2009, 15:233-41.
46. Ingle ST, Pachpande BG, Wagh ND, Patel VS and Attarde VB, Exposure to vehicular pollution and respiratory impairment of traffic policemen in Jalgaon City, India, Ind Health. 2005, 43:656-62.