Review Article

HEALTH IMPACTS OF AIR POLLUTION

Saima Saeed, Sardar Khan, Mohammad Yaseen

Department of Environmental Sciences, University of Peshawar - Pakistan

ABSTRACT

The atmosphere is a complex naturally occurring system consisting of a mixture of various gases. This system is vital for sustenance of life-cycle on the earth. The term air pollution is used, when different health damaging substances like particulate matter, organic particles, or other toxic resources are introduced into earth's environment, triggering illness and disease, allergic disorders and even demise, not only to human being but potential harm to other living entities like wildlife, food-stuff garners and other constituents of the natural human and animal habitats. Air pollution may come from man-made sources, as a result of rapid industrialization or deforestation and so forth, or from natural sources. Considering these findings, air pollution (both indoor and outdoor) was ranked as top-most dangerous global threat to life of any kind on earth.

Key Words: Air pollution, Health hazards, Respiratory diseases.

This article may be cited as: Saeed S, Khan S, Yaseen M. Health impacts of air pollution. J Med Sci 2017; 25: (3) 373-377.

INTRODUCTION

According to the WHO's estimates of 2014, there are some 7 million untimely human deaths every year attributable to air pollution worldwide.[1] Air pollution includes both indoor and out-doors air quality and their respective global statistics are as following:

Indoor air pollution

According to W.H.O. estimates of 2014, nearly three billion populations utilize solid fuels, such as coal, dung, wastes of crop, wood and charcoal for cooking purposes. As most of them are residents of low and middle income nations, unluckily they cook in open fires or unsecured stoves. Around 4.3 million deaths per annum are because of pollution caused secondarily to ineffective consumption of solid fuels for cooking purposes. The W.H.O. statistics for these deaths are: 12% are due to chest infections such as pneumonia; 34% as a result of cerebral stroke; 26% secondarily to cardiac diseases; 22% from obstructive lung diseases; and 6% due to bronchogenic carcinoma.[1]

The impact of these cooking fuels is deleterious on human health. These solid cooking and heating resources produce a variety of pollutants, which infiltrate deep into the lung parenchyma and damage them. In poorly aerated environment, smoke inside the doors can be hundred times more than threshold levels for fine particles and ending up into household air pollution. Females and youngsters are more prone to such type of devastating air pollution and the resulting ill health effect, as they spend most of their time near the domestic hearth.[2]

Saima Saeed (Corresponding Author)
Department of Environmental Sciences, University of Peshawar - Pakistan
Cell: +92-91-2601208
Email: adun.diman@gmail.com
Date Received: August 22, 2017
Date Revised: October 10, 2017
Date Accepted: October 20, 2017

Out-doors air pollution

Just like in-doors air quality, outdoor air pollution is also a main environmental hazard disturbing every person in industrialized and un-industrialized environments alike.

According to Global W.H.O. Report 2012, nearly 72% of outdoor air pollution-linked premature mortalities were caused by ischemic diseases of heart and brain; 14% of people die because of chronic lung diseases or pneumonias; and lung carcinoma amounted for 14% of the total deaths.[3]

It is important that some deaths may be due to presence of multiple risk factors in the same person. For instance, both smoking and air pollution can result into lung cancer and the risk is much higher when both of them are present in the same individual. Therefore, it is quite clear that some of the lung cancer related deaths are preventable by improving ambient air quality or by alleviating tobacco smoking.[4]

During year 2013, International Agency for Research on Cancer (IARC) established that air pollution

from out-door resources may be a contributory factor for carcinoma in human beings. They proposed a correlation among particulate matter components of air pollution and lung cancer. An association also has been detected between outdoor air pollution and upsurge in carcinomas of the urogenital tracts.[5]

It is worth mentioning that ambient air quality in both urban and rural areas was projected to be responsible for 3 million premature deaths in 2012 globally. This high percentage of premature mortalities is related to exposure of human alveolar tissues to small particulate matter of 10 microns or less in diameter. As a result, such small sized particles can breach easily deep into the lung parenchyma and can potentially cause respiratory, cardiovascular and neoplastic diseases.[6]

The W.H.O. recommended following measures to reduce the risk of ambient air pollution related deaths and ill health effects:

i. **Industrial precautions:** Every effort should be made to guarantee unpolluted technologies that diminish industrial smoke productions; upgraded management of waste, for example, arrest of methane gas released from waste locates as a substitute to incineration.

ii. **Transport related precautions:** W.H.O. recommends a comprehensive policy concerning switching to clean and unpolluted ways of power productions; prioritizing quick metro transportation system, pedestrian and cycling tracks both for urban and rural settings, rail inter-urban cargo and commuter travel systems; switching to ultra-filtered diesel automobiles and low-emissions vehicles and fuels, including gasolines with lowest sulphur content.

iii. **Cities related planning/precautions:** Every government must take every possible step regarding the improvement in the infrastructure of buildings that are more energy efficient.

iv. **Power generation related precautions:** It is the responsibility of every state to take practical steps to guarantee more use of low-emission gasolines and recyclable resources of energy (e.g.; wind, solar and hydropower); and distributed energy generation (e.g. small grids and use of solar panels).

v. **Municipal and agricultural precautions:** There must be comprehensive strategies in place for decrease in waste production, waste parting and recycling as well as improved means of waste management such as anaerobic waste digestion to produce biogas, is practicable, cost effective substitutes to the out-door burning of solidified waste materials. Strict rules and regulations should be in place where incineration is impossible.[2]

MATERIAL AND METHODS

More than 60 articles published on the impact of air pollution on human body were searched and reviewed. Key Words used during the search included: air pollution, indoor air pollution, outdoor air pollution, health hazards, human body and respiratory diseases. An abstract was arranged from these publications and formulated as current review article. Literature searching was performed on Google Scholar, Ovid, Pub Med and Medline.

Health impact of air pollution

Air pollution, both indoors and outdoors is one of the major risk factors for diseases related to pollution. Though there is an exhaustive list of the diseases caused by air pollution, some of the most important health threats include cardiovascular, respiratory and malignant diseases.

The symptoms caused by air pollution may include difficulty or shortness of breath, coughing, chest tightness, asthma and exacerbation of pre-existing cardiovascular and respiratory diseases. These symptoms and diseases may make the person affected in terms of a use of medicines, more frequent visits to doctors and hospitalization and premature mortality. The effects of air pollution are countless, but the major organs that are affected are lungs and heart.[7]

Amongst the different parameters causing individual reactions to air pollutants, few of the most important determinants are the type of pollutant, the degree of contact, and the person's existing health wellbeing and genetics. Nitrogen dioxide, Ozone and Sulphur dioxide are the main sources of air pollution. Children aged less than five years is the most vulnerable age group and hence constitutes for most deaths related to indoor and outdoor air pollution.[8,9]

a. Air pollution and cardiovascular diseases

A 2008 meta-analysis documented ambient air pollution contact as a major contributory factor for the upsurge in overall mortality due to cardiovascular morbidities such as myocardial infarction.[10] Furthermore, studies are also highlighting air pollution as a major determinant for stroke, particularly in developing countries where pollution is at its peak.[11] Interestingly, other studies are depicting that air pollution increases the risk of ischemic stroke in female population.[12] Almost similar observations were noted in other recent

studies too.[13] These associations may be pivotal and effects are caused by vasoconstriction, low range inflammatory processes and atherosclerosis.[14] Imbalance in autonomic nervous system has also been advocated as one of the contributory factors in the literature.[15]

b. Air pollution and respiratory diseases

Air pollution can initiate or exacerbate respiratory diseases. The most important link has been with chronic obstructive pulmonary diseases (COPD) which comprises of diseases like emphysema and chronic bronchitis. Literature has documented a linear relationship of air pollution with asthma and COPD.[16] Air pollution has also been linked to higher rates of hospitalization and asthma/ COPD related mortalities.[17]

A study conducted on male gender truck drivers of Post office in early 1960's, aged 40 to 59, and compared 293 London inhabitants with 477 residents of Gloucester, Peterborough, and Norwich, three urban districts having low mortality rates due to chronic bronchitis. When it was compared to the people from the distant districts, the residents of London revealed marked pulmonary morbidities and reduced functions of the lung. These dissimilarities were more marked for subjects who were in 50's age. The study which included age and habits of smoking matched controls, determined that air pollution was the most probably due to observed variances.[18]

It is also assumed that disease like cystic fibrosis, by inhabiting in urban setting, severe health problems may be more evident. Literature has demonstrated that patients who live in urban settings produce more mucus, minimised lung function capacity and have high probability of being diagnosed as patients of COPD.[19]

c. Air pollution and cancer

A 2008 literature review regarding the relationship between ambient air pollution exposure and relative risk for cancer establishes concrete statistics to recommend that long-standing contact to PM2.5 (fine particulates) raises the whole risk of non-accidental mortality by 6% per a 10 µg/m3 rise[10]. It was also established that exposure to PM 2.5 was associated with both a greater risk of death from carcinoma of lung (range: 15% to 21% per 10 µg/m3 increase) and deaths due to cardiovascular diseases (range: 12% to 14% per a 10 µg/m3 increase). It was also documented that those who live close to busy traffic routes seem to be related with greater risks of the following three outcomes: increase mortality due to carcinoma lung; cardiovascular mortality; and general non-accidental mortalities.

The researchers also established decisive proof that exposure to PM2.5 is definitely connected to increased mortality rate due to ischemic diseases of heart and exposure to SO2 increases deaths from bronchogenic carcinoma. Other studies suggested that greater activity level raises the risk of installation of aerosol particles in human lung and suggested escaping heavy activities like jogging in outdoor polluted spaces.[20]

Similarly, Danish study conducted in 2011 established higher risk of bronchogenic carcinoma in people living in settings with higher nitrogen oxide levels and that the relationship was bigger for non-smokers than smokers.21Similar results were obtained in other Danish studies too.[22]

Recently, medical experts stated that malignancy is mainly a result of environmental triggers, and not largely down to a game of chance.[23] According to W.H.O. Report, maintenance of a healthy weight, utilizing a healthy diet, reducing consumption of alcohol and quitting smoking minimize the chances to become ill and suffering from its complications.[24]

d. Air pollution and brain

There is enough data to suggest that some nervous system diseases can be linked to air pollution.[25] In a study conducted at the University of Rochester Medical Centrein 2014, it was revealed that early contact to air pollution results into similar changes in the brain parenchyma as documented in patients of autism and schizophrenia.[26] Other studies also concluded that air pollution disturbs short-term memory, learning capability, cognitive skills and impulsivity.[27] A renowned investigator, Professor Deborah Cory-Slechta stated that "When we looked closely at the ventricles of brain, we found that the white matter surrounding the brain parenchyma was not fully formed. Allegedly inflammation had damaged the brain cells and prevented them from development and the ventricles were dilated and atrophic. Our results enhance the evidence that air pollution have a role in autism and other neuro-developmental anomalies."[27]

It has been found that air pollution has a more substantial negative impact on the brains of male gender than the female. Experimental studies from 2015 stated the detection of significant intermittent intellectual deficiency from contaminations in indoor air by people in study trial who were not educated about variations in the quality of air.[28] Researchers at the Harvard University and SUNY Upstate Medical University and Syracuse University calculated the intellectual performance of 24 participants in three different controlled laboratory environments that simulated those found in "conventional" and "green" buildings, as well as green buildings with enhanced ventilation.[29] Performance was assessed objectively

using the widely used Strategic Management Simulation software simulation tool, which is an authentic test for executive decision-making in such a situation allowing creativity and lateral thinking.[30]

Strategies to control air pollution

The biggest question to be answered is; what is the solution to limit the adverse effect of air pollution? Following is the list of few of these practical and relatively easy roadmaps:

- Usage of fossil fuels for energy to be replaced by combusting ground source heat pumps and seasonal thermal energy storage
- Production of power from nuclear and renewables can be used to replace power production from burning fossil fuels.
- Automobiles driven by fossil fuels can be replaced by electric vehicles
- Ban on 2-stroke vehicles and its replacement with 4-stroke echo friendly transport supply.
- Ban on sale of used tyres.

However, as particulate matter in ambient air is the main culprit, every effort should be made to eliminate or control it. A number of studies have confirmed that control of air pollution through environmental planning is an effective tool to reduce productions of pollutants and contact of people to unpleasantly great ambient levels.

Strategies to control particulate matter (PM):

Different strategies to control particulates in the atmosphere are:

- Mechanical collector's usage
- Electrostatic precipitators: It is a particulate elimination apparatus that eliminates particles from a flowing gas using the strength of an induced electrostatic charge.
- Bag-houses to handle weighty dust masses
- A dust collector
- Particulate scrubbers are tools that extract pollutants from furnace fuel gas

CONCLUSION

Air pollution is a major hazard to human health and affects almost all major systems of human body with disastrous impact. Every possible effort both at individual and government level must be practised for the betterment of human being and environment.

REFERENCES

1. World Health Organization Report: "Air quality and health 2014." from http://www.who.int/mediacentre/factsheets/fs313/en/. Accessed date: March 28, 2017.
2. World Health Organization Report: "Energy and Air pollution 2016." From http://www.who.int/mediacentre/news/releases/2016/air-pollution-estimates/en/. Accessed date: May 22, 2017.
3. World Health Organization Report: "Air pollution factsheet 2012" from http://www.who.int/mediacentre/factsheets/fs614/en/. Accessed date: March 28, 2017.
4. Carnow BW. The "Urban factor" and lung cancer: Cigarette smoking or air pollution? Environ Health Perspect 1978; 22: 17- 21.
5. Burger M, Catto WF, Dalbagni G, Grossman BH, Herr H, Kassouf W, et L. Epidemiology and risk factors of urothelial bladder cancer. EurJ Urology 2013; 63: 234-41.
6. Pope III CA, Burnett RT, Thun MJ, Calle EE, Kreski D, Ito K, et al. Lung cancer, cardio-pulmonary mortality and long-term exposure to fine particulate air pollution. JAm Med Assoc 2002; 287: 1132-41.
7. Pope III CA, Thun MJ, Namboodiri MM, Dockery DW, Evans SJ, Spiezer EF, et al. Particulate air pollution as a predictor of mortality in a prospective study of U.S. Adults. Am JRev CritCare Med 1995; 151: 669- 72.
8. Brauer M, Hoek G, Van Vliet P, Meliefste K, Fischer PH, Wijga A, et al.Air pollution from traffic and the development of respiratory infections, asthmatic and allergic symptoms in children. AmJRev CritCare Med 2002; 166: 233-9.
9. Vallero D. Fundamentals of air pollution. Academic press; 2014.
10. Chen H, Goldberg M, Villeneuve PJ. A systematic review of the relation between long-term exposure to ambient air pollution and chronic diseases. Rev Environ Health 2008; 23: 243-97.
11. Andersen ZJ, Hvidberg M, Jensen SS, Ketzel S, Loft S, Sorensen AM,et al. Chronic obstructive pulmonary disease and long-term exposure to traffic-related air pollution: a cohort study.Am J RespirCrit Care Med 2014; 183: 455- 61.
12. Miller KA, Siscovick DS, Sheppard L, Shepherd K, Sullivan JH, Anderson GL, et al. Long-term exposure to air pollution and incidence of cardiovascular events in women."N Eng J Med 2007; 356: 447- 58.
13. Provost EB, Madhloum N, Panis LI, De Boever P, Nawrot TS. Carotid intima-media thickness, a marker of subclinical atherosclerosis, and particulate air pollution exposure: the meta-analytical evidence." PloS one 2015; 10: e0127014.
14. Louwies T, Panis LI, Kicinski M, De Boever P, Nawrot TS. Retinal microvascular responses to short-term changes in particulate air pollution in healthy adults. Envir Health Perspect 2013 (Online) 121: 1011.

15. Brook RD, Rajagopalan S, Pope III CA, Brook JR, Bhatnagar A, Diez-RouxAD,et al. Particulate matter air pollution and cardiovascular disease.Circulation 2010; 121: 2331- 78.

16. Zoidis JD. The Impact of Air Pollution on COPD. RT-MARINA DEL REY 1999; 12: 43- 6.

17. Gehring U, Wijga AH, Brauer M, Fischer P, De Jongste P, Kerkhof M, et al. Traffic-related air pollution and the development of asthma and allergies during the first 8 years of life. Am J ResCrit Care Med2010; 181: 596-603.

18. Sunyer J. Urban air pollution and chronic obstructive pulmonary disease: a review. EurResp J 2001; 17: 1024- 33.

19. Andersen ZJ, Kristiansen KC, Andersen KK, Olsen TS, Hvidberg M, Jensen SS, et al. Stroke and Long-Term Exposure to Outdoor Air Pollution From Nitrogen Dioxide.Stroke 2012; 43: 320- 5.

20. Saber E, Heydari G. Flow patterns and deposition fraction of particles in the range of 0.1–10μm at trachea and the first third generations under different breathing conditions.Computers in biology and medicine 2012; 42: 631- 8.

21. Raaschou-Nielsen O, Andersen ZJ, Hvidberg M, Jensen SS, Ketzel M, Sorensen M, et al. Lung cancer incidence and long-term exposure to air pollution from traffic.Envir Health Perspect 2011; 119: 860- 4.

22. Boffetta P,Dosemeci M, Gridley G, Bath H, Moradi T, Silverman D. Occupational exposure to diesel engine emissions and risk of cancer in Swedish men and women.Cancer Causes and Control 2001; 12: 365-74.

23. Pieters N, Koppen G, Poppel MV, De Prins S, Cox B, Dons E, et al. V. Blood pressure and same-day exposure to air pollution at school: associations with nano-sized to coarse PM in children. Envir Health perspect 2013; 123: 737- 41..

24. Diet, nutrition and the prevention of chronic diseases. World Health Organ Tech Rep Ser 2003; 916: I- VIII.

25. Genc S, Zadeoglulari Z, Fuss FH, Genc K. The adverse effects of air pollution on the nervous system.J Tox 2012;J Toxicol. 2012:782462. doi: 10.1155/2012/782462. Epub 2012 Feb 19.

26. Bos I, De Boever P, Panis LI, MeeusenR. Physical activity, air pollution and the brain.Sports Medicine 2014; 44: 1505- 18.

27. Volk, HE, Lurmann F, Penfold B, Hertz-PicciottoI, McConnell R. Traffic-related air pollution, particulate matter, and autism. JAm Med Assoc Psychiatry 2011; 70: 71- 7.

28. Allen JG, MacNaughton P, Satish U, Santanam S, Vallarino J, Spengler JD.Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments. Environ Health Perspect 2016; 124: 805- 12.

29. Wargocki P, Wyon D, Sundell J, Clausen G, Fanger PO. The effects of outdoor air supply rate in an office on perceived air quality, Sick Building Syndrome (SBS) symptoms and productivityIndoor Air-International J Indoor Air QualClim 2000; 10:222- 3.

30. Mendell MJ, Fisk WJ, Kreiss K, Levin H, Alexander D, Cain WS, et al. Improving the health of workers in indoor environments: priority research needs for a national occupational research agenda Am J Public Health 2002; 92: 1430- 40.

CONFLICT OF INTEREST: Authors declare no conflict of interest

GRANT SUPPORT AND FINANCIAL DISCLOSURE NIL

AUTHOR'S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under:

Saeed S: Concept and design/manuscript writing.

Khan S: Manuscript drafting, bibliography, critical appraised.

Yaseen M: Proof reading, referencing.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.