A Mini-Review for Causes, Effects and Preventive Measures of Choking Smog

Roheela Yasmeen*, Sahiba Zulfiqar Ali, Zunaira Baig, Uzma Rafi, Syeda Shazia Bokhari, Aisha Waheed Qurashi

Department of Biology, Lahore Garrison University, Sector-C, Av-4, phase VI, DHA Lahore, Pakistan

Corresponding Author's: raheelasattar44@gmail.com; roheelayasmeen@lgu.edu.pk

ABSTRACT

Air pollution and its increasing hazards are growing issues in Pakistan. The main reason is over population and efforts to provide luxurious lifestyles to people. So, changes in economic growth result in ever-increasing fossil fuels consumption, deforestation, industrialization, construction and urbanization. The activities are responsible for the enhanced level of airborne particles and ozone-depleting substances in the atmosphere that is resulting in low air quality especially in winter as compared to summer. Since the last few years, it was noticed in Lahore, Pakistan, that the ambient environment condition of the city is rapidly changing, particularly in winter. The sun rays are blocked out and result in smog. Smog is a combination of fog and smoke and an important secondary pollutant that reduces visibility and enhances various health issues. It particularly affects children and older people causing high risk diseases such as eye-watering, skin allergies and respiratory infections. Even though preventive measures are taken to control the effect of smog every winter, there is still a need to focus on the causes to control the prevailing problem of winter smog for betterment in the future. The present review will discuss smog's history, sources, effects and preventive measures in Pakistan along with other countries.

Keywords: Air pollution, Secondary pollutant, Winter, Visibility, Health issues

INTRODUCTION

Heavy fog in 1948 was reported in Donora, Pennsylvania that cloaked airports slowed down traffic, caused people to suffer from respiratory ailments and led to the death of 20 Donora residents [1]. This was one of the first recorded incidents of modern industrial smog. Perhaps the most well-known incident in the history of smog was the Great Smog of London in 1952. This incident has changed the concept of air pollution in terms of its impact on science, people's perception and government policies. A 'perfect storm of conditions brought on a toxic smog that engulfed the city and caused severe effects on health with an associated high mortality rate (more than 4000) and a concomitant disease rate. Domestic and industrial pollutants were found to be the main causative agents of health problems and environmental degradation in London [2]. The Great Smog of London produced pronounced effects that had ramifications including more public health insurance claims, increased hospital admission rates for cardiac and respiratory problems, pneumonia cases and influenza. All these problems were reported higher in the winter of the Great Smog of London as compared to previous years. Moreover, a higher rate of health problems not only during the smog but even months after the smog was recorded [3-5].

Severe smog episodes were also reported from different cities of China at the beginning of 2013. This smog has not only affected people's health but results in various economic losses as well [6]. According to an estimate 400, 000 premature deaths per year have been recorded in China due to air pollution [7]. In major cities of China, smog is a result of particulate matter and various gaseous emissions [8-9]. There is also raising concern in Pakistan regarding air pollution and resulting smog issues experienced in Lahore at the start of winter season 2015. Smog is an increasingly dangerous problem in Pakistan responsible for the spread of a variety of viral problems [10-11]. To the best of our knowledge, a few studies were reported on prevailing issues of smog with reference to Pakistan and those studies are limited to sources and health impacts of smog. Hence, the main objective of this study was to fill the gap in knowledge regarding preventive measures. So, the present review study emphasized on adoption of such practices within and even in neighboring countries which can help to improve air quality and to reduce the effects of this potent secondary pollutant.

MATERIALS AND METHODS

Eligibility criteria

For the present review study, 356 relevant studies were identified. However, 303 studies were excluded as 89 studies were showing duplication, 30 were books and 21 were citations. All those studies that were published prior to 1994 (117) and also not directly relating to the topic (46) were also in excluding criteria. While 53 studies were considered due to their relevance to the

topic. The inclusion criteria in the study included studies on smog's history, sources, effects and preventive measures.

Information source

To do this study, a literature review was conducted and topics related to the title were selected by using an electronic database. For database Web Science, Google Scholar, Google, and Science Direct were used and the benefits of relevant published studies were obtained.

Review Process

In the first step of study selection, all the studies with irrelevant titles were excluded. In the second step, the full text of the studies was reviewed to include those papers matching the inclusion criteria. Reference management (Mendeley version 1.8) were applied for arranging and assessing the titles and as well as for recognizing any duplicate entries. The study was conducted on the following basic steps: collecting data regarding smog's history and a brief overview of smog's episodes in various countries and their deteriorating impact on the health of people and the economy. Its major sources such as pollutants produced via fossil fuel burning, coal burning at power plants, industries and vehicular emission were seen. Finally, different controlling measures regarding smog were comprehended.

RESULTS AND DISCUSSION

For the present review study, 356 relevant studies were identified. However, 303 studies were excluded and only 53 studies were considered due to their relevance to the topic. Detail about exclusion and inclusion criteria is given in Table 1.

Table 1: Detail about exclusion and inclusion criteria.

Sr. No	Data about Studies	Numbers
1.	Total Relevant studies identified	356
2.	Duplicate studies	89
3.	Books	30
4.	Citations	21
5.	Published before 1994	117
6.	Not directly relevant to our discussed topic	46
7.	Relevant studies	53

Causes of different air pollutants and smog

It was noticed that the increase in prosperity and population growth in developing countries have resulted in excessive use of energy resources that deteriorate air quality [12]. As human populations increase, cities have rushed to keep up with different industries increasing and roads overloaded with traffic [11, 13-18]. The urban air was found enriched with harmful compounds like sulphur dioxide, nitrogen dioxide, carbon monoxide, volatile organic compounds, heavy metals, particulate matter and smog that act as health hazard pollutants [11, 19]. These pollutants were produced in the atmosphere as a byproduct of fossil fuel burning, coal burning at power plants, industries and vehicular emission and results in smog [11, 20]. Pb is used for lead-acid batteries, alloys, as an anti-knock additive in petrol, cables and chemicals. Leaded gasoline, with alkyl-lead compounds, is also used as antiknock additives [21] Pakistan is one of the developing countries that used leaded petrol in vehicles. It was also reported that almost 391 metric tons of lead are released into the atmosphere per year [22]. Similarly, in smog, the amount of Pb has been recorded as 507.4 ng/m^3 in PM_{10} concentrations [23]. According to an estimate, the air pollutants that caused smog was entered an insignificant amount in the air of Lahore from Industrial plants that was installed near the Pak border by our neighboring country (India) [24]. NASA reported that the burning of rice, on the border was a possible source of smog in Pakistan [25]. Various activities such as the burning of straw by farmers, or the use of firecrackers at functions produce a huge amount of smoke and environmental pollution. Excessive pollution in Lahore resulted in smog in the last winter in 2016 as reported by Ashraf, [26] (https://www.technologytimes.pk/smog-lahore-causes-solutions/). Industries and increasing number of vehicles and cutting down of trees declared Lahore is the second most polluted city in Pakistan [24,27-28]. Along all the factors reported by Ali and Athar, and Riaz and Hamid, [27- 28] in their studies, the increase in the number of restaurants with different cooking styles, construction of more paved roads, a number of brick kiln units in the vicinity of Lahore are also major components for the growing problem of smog. Approximately 80 % of carbonyl compounds (C1-C3) are produced during cooking, an important source of photochemical smog. The compounds were produced during varying cooking practices and may vary with different cooking oils and food materials [29]. Weather conditions were also critical in the formation of smog [20]. Stable weather conditions and coal combustion might result in severe smog. However, traffic was not a significant source for severe smog episodes according to Mira-Salama *et al.* [30]. Moreover, a controversial study that decreases in smog was also recorded in the early morning and with low traffic areas by Campbell *et al.* [31].

Levels of ammonia gas in the ambient air were very important and ammonia has shown a significant contribution to the formation of smog [32]. Due to ever increasing number of vehicles, industries, deforestation and rapid urbanization the level of pollution in an urban area like Lahore were found accelerating according to the regulation of the World Health Organization (WHO) and the National

Ambient Air Quality Standards (NAAQS) [27- 28, 33].

Effects of air pollutants and smog

Elsom, [34] reported that the world's cities were choked with pollution both from traffic and industry. Due to this ever increasing pollution, the health of 1.6 billion people is under threat, and urban air quality was realized as deteriorating day by day. The damaging effects of air pollutants were also noticed for plants and animals along with humans, both at the organ and cellular level [35-36]. Smog is one of the major secondary pollutants that greatly affecting life and the environment. The smog results in a health issue that includes some major and severe risks such as allergies, eye-watering, bronchial infections, heart problems, including asthma and lung damage tissue [6, 37-39]. Photochemical smog was recorded as a serious problem in many cities and it was more harmful to senior citizens, children, and people with heart and lung conditions such as emphysema, bronchitis and asthma. It also affects vegetation and accelerates the deterioration of rubber, plastics, paints and dyes, damage to metals, stone, concrete, clothing [40]. Bernstein *et al.* [41] had reported upper and lower respiratory problems enhanced on exposure to pollutants and showed a statistically positive association with air pollutants. Xing *et al.* and Sierra-Vargas, [42-43] also reported that the most affected people by smog were old aged, kids and those that already suffered from respiratory and cardiac problems. Furthermore, the symptoms were more pronounced in people who spent most of their time in outdoor activities [43]. The air pollutants have also shown various chronic respiratory problems like chronic obstructive pulmonary diseases (COPD), cardiovascular diseases (CVD), asthma, and cancer [44]. Hazy smoke is not only able to cause bronchitis but also decreased the UV radiation by which human beings may suffer from Vitamin D deficiency, as a result, people may have rickets disease [43].

Smog also has impacts on the natural environment that became tough for animals to survive in such conditions. It prevents the growth of plants that can lead to widespread damage to crops, trees and vegetation. As we know smog is a combination of smoke and fog, it imparts harmful effects not only on human beings and animals but also on the plants and atmosphere. Smog which also contains ground level ozone retards the plant growth hormone and affects their growth. It also damaged the seasonal crops and vegetables like wheat, rice, and cotton an essential part of the human diet. It may also cause many diseases in humans like skin and eye irritation [24, 45].

Some mitigation measures for smog

According to Wang *et al.* [46] tackling smog pollution has great importance and there is a need to enhance public environmental education and provide accessible environmental knowledge to residents. Oxidative stress effected by pollutants and controlled by the addition of supplements and food which have anti-oxidant properties [47]. There should be some preventive measures for the betterment of people to help them when they have exposure to the outdoors. During outdoor exposure, the mask should be worn. There should be a primary limitation for low emission, low carbon fuel that should be environment friendly as natural gas instead of oil and coal [48-49]. There is also a need to enhanced local community awareness about public transport as compared to individual transport. Moreover, farmers should be aware of the harms of burning crops leftover instead this uses the leftover as fertilizers. Brick kiln units are one of the important sources of black carbon, so shut down these units before the arrival of winter would be a great remedy. As it was also observed in winter 2018, the action plan of the government (to close the brick kiln units in and around the vicinity of Lahore) worked well and less smog was noticed as compared to the previous two years. Moreover, we need to implant smog-eating towers that suck up injurious and toxic chemicals and filtered the quality air before release. However, there is a need to use smog-free bikes and smog sucking vacuum towers even though, all the mentioned technologies were found expensive and difficult to put into practice [50-52]. Smog can be reduced 10% by planting more trees as these lowers the air temperature [53].

CONCLUSION

It is concluded that due to an increase in population and technology, developing countries have seen an excessive use of energy resources that accumulate pollutants and in turn deteriorating air quality. There are various sources for these pollutants such as industries, transport, carbonyl compounds from food and food products, ammonia, black carbon from brick kiln industries and deforestation etc. The noxious chemicals result in smog and produce various harmful effects on vegetation, animals and human health. Moreover, there is a need to educate people on how to behave during smog and to take different strategic measures to cut down on smog-causing agents.

ETHICAL ISSUES

Ethical issues have been completely observed by the authors.

CONFLIT OF INTEREST

There is no conflict of interest to be declared.

AUTHOR'S CONTRIBUTIONS

All authors equally contributed to write this review article.

FUNDING/ SUPPORTS

The project was supported financially by the authors.

REFERENCES

[1] Snyder LP. "The Death-Dealing Smog over Donora, Pennsylvania": Industrial Air Pollution, Public Health Policy, and the Politics of Expertise, 1948-1949. Environmental History Review. 1994; 18(1): 117-39.
[2] Brimblecombe P. The Big Smoke (Routledge Revivals): A History of Air Pollution in London since Medieval Times. Routledge. 2012.
[3] Bell ML, Davis DL, Fletcher T. A retrospective assessment of mortality from the London smog episode of 1952: the role of influenza and pollution. Environmental health perspectives. 2004; 112(1): 6-8.
[4] Bell ML, Davis DL. Reassessment of the lethal London fog of 1952: novel indicators of acute and chronic consequences of acute exposure to air pollution. Environmental health perspectives. 2001;109 (suppl 3): 389-94.
[5] Hunt A, Abraham JL, Judson B, Berry CL. Toxicologic and epidemiologic clues from the characterization of the 1952 London smog fine particulate matter in archival autopsy lung tissues. Environmental health perspectives. 2003; 111(9): 1209-14.
[6] Zhang D, Liu J, Li B. Tackling air pollution in China—What do we learn from the great smog of 1950s in London. Sustainability. 2014 ; 6(8):5322-38.
[7] Watts J. China: the air pollution capital of the world. The Lancet. 2005; 366 (9499): 1761-62.
[8] Qiu. Fight against smog ramps up: Chinese government to provide incentives for heavy polluters to go green, but analysts question whether its wider air-quality strategy goes far enough. Nature. 2014; 506(7488): 273-75.
[9] David H, Juyuan J. A study of smog issues and PM 2.5 pollutant control strategies in China. Journal of Environmental Protection. 2013; 4(07): 746.
[10] Raja MU, Mukhtar T, Shaheen FA, Bodlah I, Jamal A, Fatima B, Ismail M, Shah I. Climate change and its impact on plant health: a Pakistan's prospective. Plant Protection. 2018; 2(2): 51-56.
[11] Ali Y, Razi M, De Felice F, Sabir M, Petrillo A. A VIKOR based approach for assessing the social, environmental and economic effects of "smog" on human health.Science of the Total Environment.2019; 650: 2897-05.
[12] Sun C, Yuan X, Xu M. The public perceptions and willingness to pay: from the perspective of the smog crisis in China. Journal of Cleaner Production. 2016; 112: 1635-44.
[13] Biswas KF, Ghauri BM, Husain L. Gaseous and aerosol pollutants during fog and clear episodes in South Asian urban atmosphere. Atmospheric Environment. 2008; 42 (33): 7775-85.
[14] Stone E, Schauer J, Quraishi TA, Mahmood A. Chemical characterization and source apportionment of fine and coarse particulate matter in Lahore, Pakistan. Atmospheric Environment. 2010; 44(8):1062-70.
[15] Shah MH, Shaheen N, Nazir R. Assessment of the trace elements level in urban atmospheric particulate matter and source apportionment in Islamabad, Pakistan. Atmospheric pollution research. 2012; 3(1):39-45.
[16] Rasheed A, Aneja VP, Aiyyer A, Rafique U. Measurement and analysis of fine particulate matter (PM2. 5) in urban areas of Pakistan. Aerosol and Air Quality Research. 2015; 15(2): 426-39.
[17] Ali Z, Rauf A, Sidra S, Nasir ZA, Colbeck I. Air quality (particulate matter) at heavy traffic sites in Lahore, Pakistan. Journal of Animal and Plant Sciences. 2015; 25(3): 644-48.
[18] Molina C, Toro R, Manzano C, Leiva-Guzmán MA. Particulate matter in urban areas of south-central Chile exceeds air quality standards. Air Quality, Atmosphere & Health. 2017; 10(5): 653-67.
[19] Kampa M, Castanas E. Human health effects of air pollution. Environmental pollution. 2008; 151(2):362-67.
[20] Jiang L, Hiltunen E, He X, Zhu L. A questionnaire case study to investigate public awareness of smog pollution in China's rural areas. Sustainability. 2016; 8(11): 1111.
[21] Kabata-Pendias A, Mukherjee AB. Trace elements from soil to human. Springer Science & Business Media. 2007.
[22] Parekh PP, Khwaja HA, Khan AR, Naqvi RR, Malik A, Khan K, Hussain G. Lead content of petrol and diesel and its assessment in an urban environment. Environmental monitoring and assessment. 2002; 74(3):255- 62.
[23] Wang J, Niu H, Ling P, Fan J, Luo K, Blokhin M, Sun Y. The smog pollution in Handan-a mining and industrial city in China. World Journal of Engineering, 2014; 11(6): 613-20.
[24] Butt MU, Waseef RF, Ahmed H. Perception about the Factors Associated with Smog among Medical Students. Biomedica. 2018; 34(4): 264.
[25] Khan, A. Evaluation of Industrial Environmental Management-Pakistan. Report Prepared for the Ministry of Industries, Islamabad. 2010.
[26] Ashraf MN 2017. Available at: https://www.technologytimes.pk/smog-lahore-causes-solutions/

[27] Ali M, Athar M. Impact of transport and industrial emissions on the ambient air quality of Lahore City, Pakistan. Environmental monitoring and assessment. 2010; 171(1): 353-63.
[28] Riaz R, Hamid K. Existing smog in Lahore, Pakistan: an alarming public health concern. Cureus. 2018;10(1). e2111. 1-3.
[29] Xiang Z, Wang H, Stevanovic S, Jing S, Lou S, Tao S, Li L, Liu J, Yu M, Wang L. Assessing impacts of factors on carbonyl compounds emissions produced from several typical Chinese cooking. Building and Environment. 2017; 125:348-55.
[30] Mira-Salama D, Grüning C, Jensen NR, Cavalli P, Putaud JP, Larsen BR, Raes F, Coe H. Source attribution of urban smog episodes caused by coal combustion. Atmospheric Research. 2008; 88(3-4):294-04.
[31] Campbell ME, Li Q, Gingrich SE, Macfarlane RG, Cheng S. Should people be physically active outdoors on smog alert days?. Canadian journal of public health. 2005; 96(1): 24-28.
[32] Li K, Chen L, White SJ, Yu H, Wu X, Gao X, Azzi M, Cen K. Smog chamber study of the role of NH3 in new particle formation from photo-oxidation of aromatic hydrocarbons. Science of the Total Environment. 2018; 619: 927-37.
[33] Pak-EPA (2005) State of the environment report. Pakistan Environmental Protection Agency, Ministry of Environment, Government of Pakistan. Available from: http://environment.gov.pk/state-ofenvironment-report/ 27–6-2016 (accessed 08.07.2016)
[34] Elsom D. Smog alert: managing urban air quality. Earthscan Routledge; 2014 Apr 4. 1-94.
[35] Iriti M, Faoro F. Oxidative stress, the paradigm of ozone toxicity in plants and animals. Water, Air, and Soil Pollution. 2008; 187(1):285-01.
[36] Gheorghe IF, Ion B. The effects of air pollutants on vegetation and the role of vegetation in reducing atmospheric pollution. The impact of air pollution on health, economy, environment and agricultural sources. 2011; 29: 241-80.
[37] Pakbin P, Hudda N, Cheung KL, Moore KF, Sioutas C. Spatial and temporal variability of coarse (PM10− 2.5) particulate matter concentrations in the Los Angeles area. Aerosol Science and Technology. 2010; 44(7):514-25.
[38] Sughis M, Nawrot TS, Ihsan-ul-Haque S, Amjad A, Nemery B. Blood pressure and particulate air pollution in schoolchildren of Lahore, Pakistan. BMC Public Health. 2012; 12(1): 1-8.
[39] Chen R, Zhao Z, Kan H. Heavy smog and hospital visits in Beijing, China. American journal of respiratory and critical care medicine. 2013; 188(9):1170-71.
[40] Rani B, Singh U, Chuhan AK, Sharma D, Maheshwari R. Photochemical Smog Pollution and Its Mitigation Measures. Journal of Advanced Scientific Research. 2011; 2(4): 28-33.
[41] Bernstein JA, Alexis N, Barnes C, Bernstein IL, Nel A, Peden D, Diaz-Sanchez D, Tarlo SM, Williams PB. Health effects of air pollution. Journal of allergy and clinical immunology. 2004; 114(5): 1116-23.
[42] Xing YF, Xu YH, Shi MH, Lian YX. The impact of PM2. 5 on the human respiratory system. Journal of thoracic disease. 2016; 8(1): E69-E74.
[43] Sierra-Vargas MP, Teran LM. Air pollution: impact and prevention. Respirology. 2012; 17(7): 1031-38.
[44] Yang W, Omaye ST. Air pollutants, oxidative stress and human health. Mutation Research/Genetic Toxicology and Environmental Mutagenesis. 2009; 674(1-2):45-54.
[45] Larry W. "The Causes and Effects of Smog." Thought Co, Aug. 23, 2018, thoughtco.com/what-is-smog-causes-and-effects-1204194. 2018, available at: https://www.thoughtco.com/what-is-smog-causes-and-effects-1204194
[46] Wang Y, Sun M, Yang X, Yuan X. Public awareness and willingness to pay for tackling smog pollution in China: a case study. Journal of Cleaner Production. 2016; 112:1627-34.
[47] Poljsak B, Fink R. The protective role of antioxidants in the defence against ROS/RNS-mediated environmental pollution. Oxidative medicine and cellular longevity. 2014 . Volume 2014 |Article ID 671539. Available at: | https://doi.org/10.1155/2014/671539
[48] Liang FY, Ryvak M, Sayeed S, Zhao N. The role of natural gas as a primary fuel in the near future, including comparisons of acquisition, transmission and waste handling costs of as with competitive alternatives. Chemistry Central Journal. 2012; 6(1):1-24.
[49] Shi H, Wang Y, Chen J, Huisingh D. Preventing smog crises in China and globally. Journal of Cleaner Production. 2016; 112:1261-71.
[50] Mellino S, Petrillo A, Cigolotti V, Autorino C, Jannelli E, Ulgiati S. A Life Cycle Assessment of lithium battery and hydrogen-FC powered electric bicycles: Searching for cleaner solutions to urban mobility. International Journal of Hydrogen Energy. 2017; 42(3):1830-40.
[51] Ali Y, Razi M, De Felice F, Sabir M, Petrillo A. A VIKOR based approach for assessing the social, environmental and economic effects of “smog” on human health. Science of the Total Environment. 2019; 650:2897-05.
[52] Dahal A, Dhakal P, Farooqui AA. Role of information technology for the improvement of climate change in the context of Nepal. 2020. A technical report. DOI: 10.13140/RG.2.2.20953.13922
[53] Rosenfeld AH, Akbari H, Romm JJ, Pomerantz

M. Cool communities: strategies for heat island mitigation and smog reduction. Energy and buildings. 1998 Aug 1;28(1):51-62.