

Original Article

ENVIRONMENTAL POLLUTION EFFECTS ON PUBLIC HEALTH

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ABSTRACT

Background: Environmental pollution impacts public health and is accountable for causing many of the current environmental challenges and issues. To face environmental challenges, environmental education is a necessary factor to look after. An effort was made to find out the major source of environmental pollution, the relationship between sources of pollution, and the public health issues due to environmental pollution.

Material and Methods: A cross-sectional survey method was used. Using a systematic random sampling technique, data was collected from 429 households in Samanabad Town (225 households from UC-86, 204 households from UC-107, one person from each household). Data were analyzed by using SPSS 21.

Results: The study indicates that burning, winter heating, and construction workers found the major sources of environmental pollution and cause of multiple health issues: eyes and pulmonary. It is creating serious issues in social life, such as dust, traffic jam, emergencies, fewer outdoor activities and social distancing. Traffic issues create sudden emergencies affecting public health negatively.

Conclusion: Public awareness through education on environmental changes and climate, tree plantation and social education for the adoption of safety measures about and health seems to be a health-conscious approach; how to live a safe life needed to be addressed: social education and health education along with the polluted free friendly environment.

Key Words: Environmental Pollution, Public health, Health education

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INTRODUCTION

Human health and well-being have always been considered important on the earth's planet. The increasing population, industrialization, urbanization/habitat destruction and energy produced diversified effects on the environment and put nature under pressure. Deterioration in the ecosystem threatens human life and other living organisms.

Today's world focuses on controlling air and water pollution because it is a significant driver causing the extinction of animals and plants no doubt necessary to maintain a balance in nature. Transformative changes (direct/indirect drivers of pollution) need to be addressed. The Global Conference on "Health and Climate Change 2021" focuses especially on "Climate Justice and the Healthy and Green Recovery from COVID-19".¹ It was in line with the WHO Manifesto: nature, food systems, sustainable infrastructure, clean energy, cities and stopping pollution.² In the first-ever Global Conference on "Air Pollution and Health" (2018) the Director General of the World Health Organization, Dr. Tedros Adhanom Ghebreyesus, informed that air pollution is a

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"silent public health emergency" and "the new tobacco".^{3,4}

People living in hot areas of developing countries are vulnerable to environmental pollution, especially children and elderly people.⁵ According to UN Climate Change News Oct 26, 2018 about the first-ever Global Conference on "Air Pollution and Health" organized by the World Health Organization (WHO) and with the participation of UN Climate Change identified the sources and solutions: invest in energy-efficient power generation; improve the domestic, industry and municipal waste management; make greener and more compact cities with energy-efficient buildings; reduce agricultural waste incineration and forest fires; build safe and affordable transport systems; and universal access to clean, affordable fuels and technologies for cooking, heating and lighting.⁶ Conferences and debates on Climate Change and Environmental pollution highlighted the harmful effects on health, especially in developing countries.

Pakistan has been facing such problems for decades, especially in metropolitan areas. Air pollution in Pakistan ranked the country as the second most polluted globally with an annual PM_{2.5} average of 74.3µg/m. City Lahore is ranked 1 in IQ Air.⁷ another city, Faisalabad, 's air pollution was found at number 3. Air pollution in Islamabad (Capital city of Pakistan) was found lower at number 239 which is quite significant. City Karachi's air pollution was at number 318, the lowest among the four cities. After IQ-AIR visuals Report about air pollution, the government of Pakistan took serious action against it. The government orders to prepare an action plan to publish daily along with hourly updates about the air Quality work. Unfortunately, efforts were declined due to unsatisfactory responses. In November 2019 some private NGOs and individuals from the public sector started to work for it.

In the first half of 2019, the United States Embassy in Islamabad and the three U.S. Consulates in Karachi, Lahore and Peshawar began monitoring air quality. They started to

publish PM_{2.5} data online about Pakistan due to the worst air quality. Reason indicated by the media is the crops burning and the celebrations of festivals across the borderline in India. These activities raised the worst environmental pollution in Lahore and pushed it towards the top ranking of globally polluted cities.

The increase in population, expanding cities with mega projects of industries, and excessive use of automobiles are causing smog, badly affecting public health.^{8,9} In winter, wood and coal combustion are also the source of smog.¹⁰ In winter smog became heavier because of its density.¹¹ Household solid fuel combustion and cooking fires are other sources of pollution caused environmental health problems. Studies show that exposure to pollution from cooking fires globally affected almost 3 billion people which is 40% of the global population. Burning wood, coal, and added solid fuels for everyday cooking food are the sources that create the environmental health problems.¹²⁻¹⁵

Industrial development, coal plant emissions and coal combustion, uncontrolled cutting of trees, rapid infrastructure development, open burning of rice stubble and solid waste and emission of all burned substances are the causes of smog production.¹⁶ Smoke and smog contain gases and particles not limited to those who breathe in it, but also damage climate.¹⁵ Factories, multivehicle, winter heating and combustion and construction activities emit PM 2.5 and PM 10 particles,¹⁷ Chemicals and Automobiles are also the major causes of smog pollution.^{18,19}

The emerging issues of air pollution causing respiratory and pulmonary diseases, skin and eye infections and asthma are broadly recognized as serious by air pollution exposure (World Health Organization 2019; Castner, 2016). Young and old people are affected badly. Environmental pollution is not only affecting physical but also psychological health that negatively affects human routines which in-turn affects social and economic human health.²⁰ Meade, K. (2014)²¹ stated about a series of research

efforts that focused on the city of Los Angeles where researcher look at the intersection of ambient air quality and school performance in California. The study finding correlates the respiratory hazards from air toxins with lower academic performance. Another study of Mohai, P., Kweon, B., Lee, S. and Ard, K., (2011)²² indicates the highest proportions of students who failed to meet state educational examining standards in schools located in areas having the highest air pollution levels in Michigan. At community level, general issues due to dust faced by the public are: traffic problems and low visibility.²³

Environmental pollution can cause brain drain. It increases social distance and reduce social relationships due to less outdoor activities.²⁴ A sudden break in speedy life is creating frustrations in social, physical and psychological life. Depression, anxiety and restlessness reflected through different modes and irritation in behavior due to unexpected and uncomfortable environment.²⁵

Global agenda "clean and green environment" indicates the horrifying increase and worse situations.²⁶ Nature is badly affected due to pollution. There is a great need to enhance the knowledge and awareness to focus on this issue at all levels: individual and government. Adoption of measures to control pollution and prevention will be helpful for all to face environmental challenges. Awareness among masses is the need of time. Government campaigns to alert public through media during weather emergencies to safe from motor/highways road accidents; addressed visibility issues and adoption of other safety measures.²⁷

The aim of this article was to find out the major sources of environmental pollution; to see the effects of sources of environmental pollution on public health and social life and to see either there is any relationship between the sources of environmental pollution, public health issues and social life.

MATERIAL AND METHODS

A cross sectional survey method was used. Probability sampling procedure was adopted. Mixed methodology (quantitative and qualitative techniques) was used to get in-depth information. A questionnaire was designed having closed ended and open-ended questions. Lahore - a metropolitan city was selected where people used to come and live for the sake of studies, employment and business. The population of Lahore in 2022 is 13,542,000, a 3.41% increase from 2021.²⁸ According to the "Lahore Population Report 2022", population density currently sits around 6,300 residents per square kilometer (16,000 individuals per square mile).²⁹ Using systematic random sampling technique, out of nine towns (Wahga, Aziz Bhatti, Gulberg, Shalimar, Nishtar, Data Gunj Buksh, Allama, Samanabd, and Ravi) Samanabad Town was selected having 31 Union Councils. Out of 31 Union Councils, two Union Councils were randomly selected (UC86-New Samanabad and UC107-Pakki Thatti). Population was 56823 and 62019 respectively.²² Total population of both UC's (86 and 107) was 118,842. Total households were 19706 (10336+9370 respectively). Sampling interval was 46. Every 46 house was selected. Out of total households (19706), 225 households were selected from UC-86 and 204 households were selected from UC-107 (one person from each household). Questionnaire was divided into four sections: demographic information (age, gender, level of education, marital status, and occupational status); sources of pollution (automobiles; burning; construction; and winter heating); environmental factors affecting public health and disturbing social life. Last section contained open ended questions regarding feasible suggestions/solutions. The questionnaire was consisted of 45 questions (40-closes ended and 5-open ended). Five-point Likert scale was used to measure the responses (1-strongly agree to 5- strongly disagree) in the close ended questions.

Data was analyzed in SPSS-21. Descriptive (frequency and percentage) and inferential

statistics (Chi-square Test, Correlations and Multiple Regression) were applied on the data set. Frequencies (*f*) and percentages (%) were used to find out the demographic information (age, gender, marital status, level of education, and occupational status) of the respondents and to find out the major sources of pollution. Pearson's Chi-square (χ^2) was used to observe the effects of different sources of environmental pollution on public health as well as on the social life. Correlation and multiple regression was used to see either there is any relationship between various sources of environmental pollution, public health issues and in the social life.

RESULTS

For demographics, data shows that out of 429 respondents, there were 246(57%) males and 183(43%) females, 156(35%) were from the age group of 0 to 20 years, 107(25%) were from the age between 21 to 40 years, 79(6%) were from the age group of 41 to 60 years and 87(6%) were from the age group of 60 years and above, 231(51%) ever married and 198(46%) never married, 156(34%) were having fundamental education, 112(26%) have secondary education, 97(23%) have university level education and 74(17%) have other types of education, 265(62%) were working while 164(44%) were from non-working class.

Table 1: Respondents Demographics

Demographic Variables	N	%
Gender		
Male	246	57
Female	183	43
Age (Years)		
0-20	156	35
21-40	107	25
41-60	79	6
60 &above	87	18
Marital Status		
Married	231	51
Single	198	46
Education		
Fundamental	156	34
Secondary	112	26
University	97	23
Informal	74	17
Occupational Status		
Working	265	62
Non-working	164	44

About the major source of pollution, it was observed that public (57%-strongly agree) categorically mentioned that burning is the major source of environmental pollution.

Regarding public health issues, the results indicate a toxic effect of burning on eyes ($\chi^2 = .000$, $df = 2$, $p < 0.05$). Burning is a source of pulmonary health disorder ($\chi^2 = .043$, $df=2$, $p < 0.05$) whereas winter heating detrimental effects on eyes ($\chi^2 = .000$, $df=2$, $p < 0.05$), creating pulmonary disorder ($\chi^2 = .000$, $df=2$, $p < 0.05$), chest ailments ($\chi^2 = .044$, $df=2$, $p < 0.05$) and skin damaging effects ($\chi^2 = .000$, $df=2$, $p < 0.05$).

Table 2: Environmental Pollution effects on Public Health

Sources of Pollution	Eye	Pulmonary	Chest	Skin
Motor Vehicles	.857	.761	.980	.585
Burning	.000	.043	.790	.788
Construction	.009	.012	.074	.230
Winter Heating	.000	.000	.044	.000

Pearson's χ^2 significant at $p < 0.05$

Main causes are the motor vehicles and use of winter fuel that adversely affecting health such as eyes, pulmonary, chest and skin problems. Another source - construction is also a cause of eyes allergies, pulmonary disorder and chest infections and allergies whereas burning destructively damaging eyes and pulmonary issues. The most significant cause is winter heating, which badly affects all four health issues.

There are significant relationship between social distancing and burning ($\chi^2 = .038$, $df=2$, $p < 0.05$); construction work with traffic ($\chi^2 = .068$, $df=2$, $p < 0.05$), winter heating ($\chi^2 = .000$, $df=2$, $p < 0.05$), and emergency situations ($\chi^2 = .000$, $df=2$, $p < 0.05$). Burning, construction work, specifically winter heating, were the main sources of environmental pollution that slowdown the pace of social life.

Table 3: Sources of Pollution disruption in Social Life

Sources of Pollution	Traffic	Emergency Situations	Outdoor Activities	Social Distancing
Automobiles	.483	.855	.281	.131
Burning	.806	.433	.958	.038
Construction work	.068	.191	.842	.061
Winter Heating	.000	.000	.113	.061

Pearson’s χ^2 significant at $p < 0.05$.

The results indicate that using fuel for heating during winter significantly affects social life (traffic flow on roads, handling emergency situations and social distancing). Construction material and construction work block the roads along with the side paths that disturb traffic flow and pedestrians. Vehicles smoke during traffic jams not only a serious cause of environmental pollution but also wastage of time unable public to observe school and office/duty timings. Dust due to construction work and smoke due to

burning create social distancing as public avoid from such places.

Burning had a negative correlation with the skin problems ($r = -0.009$). Winter heating had negative correlations with the skin problems ($r = -0.048$) and social distancing ($r = -0.019$).

Construction work and winter heating strongly correlated with the eye problems ($r = 0.104^*$) and ($r = 0.144^*$) and reduction in the outdoor activities ($r = 0.105^*$). Data also shows that traffic blockage and emergency situations strongly correlated with the chest problems ($r = 0.264^{**}$) and ($r = 0.315^*$).

Data shows that a strong correlation exists between skin problems with "emergency situations" ($r = 0.253^{**}$) and with "social distancing" ($r = 0.135^{**}$); Traffic strongly correlated with "reduction in the outdoor activities" (0.235^{**}) and "emergency situations" also strongly correlated with "social distancing" ($r = 0.179^{**}$).

Table 4: Relationship between Sources of Environmental Pollution, Health issues and Social Life

	1	2	3	4	5	6	7	8	9	10	11	12
Automobiles	1.000											
Burning	1.64*	1.000										
Construction	0.00*	1.54**	1.000									
Winter heating	0.051	0.189* *	0.398* *	1.000								
Eye Allergies	0.074	0.249**	0.104*	0.144**	1.000							
Pulmonary blockage	-0.012	0.060	0.040	0.017	0.377**	1.000						
Chest issues	-0.018	0.007	0.034	0.035	0.036	0.244**	1.000					
Skin Allergies	-0.039	-0.009	-0.070	-0.048	0.063	0.028	0.438**	1.000				
Traffic disorder	0.010	0.054	0.006	0.055	0.098	-0.003	0.264**	0.397**	1.000			
Emergency situations	-0.106*	0.020	0.044	0.060	0.039	0.032	0.315**	0.253**	0.338**	1.000		
Reduction in outdoor activities	-0.032	0.084	-0.003	0.105*	-0.011	-0.074	0.073	0.087	0.235**	0.394**	1.00	
Social distancing	0.021	0.068	-0.108*	-0.019	-0.011	0.054	0.033	0.135**	0.090	0.179**	0.297**	1.000

**Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (1-tailed).

The results suggest positive and negative effects that differently related with each other. Among the sources of environmental pollution "Automobiles" mostly caused eye allergies ($r = -0.074$) and negative relationship with the skin problems ($r = -0.039$); chest problems ($r = -0.018$) and pulmonary ($r = -0.012$) and emergency situations ($r = -0.106$). The second source of environmental pollution "Burning" mostly created eye allergies ($r = 0.249^{**}$). A negative correlation found in "Burning" with skin problems ($r = -0.009$), reduction in the outdoor activities ($r = -0.084$) and social distancing ($r = -0.068$). Construction work strongly correlated with the eye allergies ($r = 0.104^*$). Construction work had a strong but negative correlation with social distancing ($r = -0.108^*$). Construction had also a strong correlation with pulmonary problems ($r = 0.040$) and chest blockage ($r = 0.035$). Winter heating correlated with the eye problems ($r = 0.144^{**}$) and with the reduction in the outdoor activities ($r = 0.105^*$). Winter heating showed negative correlations with the social distancing ($r = -0.019$) and skin problems ($r = -0.048$) and a positive correlation with chest problems ($r = 0.035$).

Burning, winter heating and construction work identified as the major sources of environmental pollution that adversely affected health (eyes allergies and pulmonary issues and also creating hurdles in the social life (flow of traffic, problems to handle the emergency situations, reduction in the outdoor activities and caused social distancing. Jam traffic creates sudden emergency situations such as anxiety, loss of self-control (use of abusive language, violence and destructive attitude), and wastage of time that sometimes resulted in heavy losses affecting health in a negative way and dismantling the social fabric.

DISCUSSION

The Global Conference on "Health and Climate Change 2021" focuses specially on "Climate Justice and the Healthy and Green Recovery from COVID-19".³⁰ It was in line

with the WHO Manifesto: nature, food systems, sustainable infrastructure, clean energy, cities, and stopping pollution.³¹ In the first-ever Global Conference on "Air Pollution and Health" (2018) the Director General of World Health Organization Dr. Tedros Adhanom Ghebreyesus informed that air pollution a "silent public health emergency" and "the new tobacco".^{32,33} People who are living in hot areas of developing countries are vulnerable to the environmental pollution especially children and elderly people.³⁴ According to UN Climate Change News 26 October 2018 about the first-ever Global Conference on "Air Pollution and Health" organized by the World Health Organization (WHO) and with the participation of UN Climate Change identified the sources and solutions: invest in energy-efficient power generation; improve domestic, industry and municipal waste management; make greener and more compact cities with energy-efficient buildings; reduce agricultural waste incineration and forest fires; build safe and affordable transport systems; and universal access to clean, affordable fuels and technologies for cooking, heating and lighting.³⁵

Conferences and debates on Climate Change and Environmental pollution highlighted the harmful effects on health specially in the developing. Suggested solutions emphasized that public awareness, boosting education, training, and public participation measures have been taken to maximize the opportunities to achieve the targets and goals regarding the critical issues of environmental pollution.³⁶ Due to the critical seriousness of the increasing silent danger the Government of Pakistan took "Clean and Green Pakistan" initiative. To reduce the air pollution, tree plantation campaigns had been started with the involvement of private sector at all levels. Public participation is important to control the harmful impacts environmental pollution on health.

This study indicates burning-a major source of pollution. Similar findings indicated by Su et al. (2015) study that "burning is the

main cause of smog including burning of coal, oil and natural gas and electricity accounted for over 96% of Beijing's total energy consumption".³⁷

Automobiles/vehicles caused pulmonary problems whereas construction and winter heating caused social distancing.³⁸ Burning, construction work, specifically winter heating were found the main source of pollution affecting public health: eye irritation and respiratory problems; traffic issues (low visibility, accident ratio, high way and motor ways blockage, tourism banned)³⁹ and emergency situations (strikes, awful working conditions, financial crises etc).^{40,41} Motor Vehicles do not found to be a significant factor/source of environmental pollution. A significant relationship was found between burning, construction work, and winter heating.

CONCLUSION

Public awareness through environmental education, social education, health education and safety measures for public awareness will be step towards a conscious approach of living a healthy and safe life. "Now and Never" strategy is needed to address the serious issues and change the Lahore city into healthy, safe, and friendly pollution free environment.

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AUTHOR'S CONTRIBUTION

BY: Conceptualization, Introduction, Methodology, Data Analysis, Writing – Original draft preparation.

NJ: Visualization, Review of literature, Data entry, discussion the manuscript and Results.

MZK: Data Collection, Critical Evaluation, Referencing, Final Editing Revising.

REFERENCES

1. WHO Global Conference on Health and Climate Change. 2021. [https://www.who.int/news-](https://www.who.int/news-room/events/detail/2021/11/06/default-calendar/2021-global-conference-on-health-and-climate-change)

[room/events/detail/2021/11/06/default-calendar/2021-global-conference-on-health-and-climate-change](https://www.who.int/news-room/events/detail/2021/11/06/default-calendar/2021-global-conference-on-health-and-climate-change)

2. World Health Organization Report. Air Pollution. Geneva, Switzerland: W H O .2019. <https://www.who.int/health-topics/air-pollution>
3. WHO Report May 2020. <https://www.who.int/health-topics/air-pollution>.
4. World Health Organization. First WHO Global Conference on Air Pollution and Health, 2018. <https://www.who.int/airpollution/events/conference/en/>
5. Park B, Kim S, Park S, Kim M, Kim TY, Park H. Development of Multi-Item Air Quality Monitoring System Based on Real-Time Data. *Applied Sciences*. 2021 Oct 19;11(20):9747. <https://doi.org/10.3390/app11209747>
6. WHO Report 2018 on United Nations Climate Change) First-ever Global Conference on Air Pollution and Health (<https://unfccc.int/news/first-ever-global-conference-on-air-pollution-and-health>)
7. Feenstra B, Papapostolou V, Hasheminassab S, Zhang H, Der Boghossian B, Cocker D, Polidori A. Performance evaluation of twelve low-cost PM2.5 sensors at an ambient air monitoring site. *Atmospheric Environment*. 2019 Nov 1;216:116946. <https://doi.org/10.1016/j.atmosenv.2019.116946>
8. Chaichan MT, Kazem HA. Single slope solar distillator productivity improvement using phase change material and Al2O3 nanoparticle. *Sol Energy*. 2018 Apr 1;164:370-81. <https://doi.org/10.1016/j.solener.2018.02.049> www.elsevier.com/locate/solener
9. Wang H, Naghavi M, Allen C, Barber RM, Bhutta ZA, Carter A, Casey DC, Charlson FJ, Chen AZ, Coates MM, Coggeshall M. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015. *The Lancet*. 2016 Oct 8;388(10053):1459-544. [https://doi.org/10.1016/S0140-6736\(16\)31012-1](https://doi.org/10.1016/S0140-6736(16)31012-1).

10. Chung CY, Chung PL. Assessment of carbon dioxide reduction efficiency using the regional carbon neutral model—A case study in University campus, Taiwan. *Low Carbon Econ.* 2011 Sep 1;2:159-64. doi:10.4236/lce.2011.23020
11. Bare J. TRACI 2.0: the tool for the reduction and assessment of chemical and other environmental impacts 2.0. *Clean Technol Envir Policy.* 2011 Oct;13(5):687-96. <https://doi.org/10.1007/s10098-010-0338-9>.
12. Bonjour S, Adair-Rohani H, Wolf J, Bruce NG, Mehta S, Prüss-Ustün A, Lahiff M, Rehfuess EA, Mishra V, Smith KR. Solid fuel use for household cooking: country and regional estimates for 1980–2010. *EHP.* 2013 Jul;121(7):784-90. doi:10.1289/ehp.1205987.
13. Chafe R, Harnum D, Porter R. Improving the treatment and assessment of moderate and severe pain in a pediatric emergency department. *Pain Res Manag.* 2016 Oct;2016. doi:10.1155/2016/4250109
14. Smith, KR., *Biofuels, Air Pollution, and Health: A Global Review.* 2013. New York: Plenum Press. <https://link.springer.com/book/10.1007/978-1-4613-0891-1>
15. Smith KR, Bruce N, Balakrishnan K, Adair-Rohani H, Balmes J, Chafe Z, Dherani M, Hosgood HD, Mehta S, Pope D, Rehfuess E. Millions dead: how do we know and what does it mean? Methods used in the comparative risk assessment of household air pollution. *Annu Rev Public Health.* 2014 Mar 18;35(1):185-206. doi: 10.1146/annurev-publhealth-032013-182356.
16. Ontawong A, Saokaew S, Jamroendarasame B, Duangjai A. Impact of long-term exposure wildfire smog on respiratory health outcomes. *Expert Rev Respir Med.* 2020 May 3;14(5):527-31. <https://doi.org/10.1080/17476348.2020.1740089>
17. Shupler M, Godwin W, Frostad J, Gustafson P, Arku RE, Brauer M. Global estimation of exposure to fine particulate matter (PM_{2.5}) from household air pollution. *Environ. Int.* 2018 Nov 1;120:354-63. <https://doi.org/10.1016/j.envint.2018.08.026>
18. Wang F, Zheng P, Dai J, Wang H, Wang R. Fault tree analysis of the causes of urban smog events associated with vehicle exhaust emissions: A case study in Jinan, China. *Sci Total Environ.* 2019 Jun 10;668:245-53. <https://europepmc.org/article/med/30852201> doi: 10.1016/j.scitotenv.2019.02.348
19. Yang LE, Hoffmann P, Scheffran J. Health impacts of smog pollution: The human dimensions of exposure. *Lancet Planet. Health.* 2017 Jul 1;1(4):e132-3. [http://dx.doi.org/10.1016/S2542-5196\(17\)30067-0](http://dx.doi.org/10.1016/S2542-5196(17)30067-0)
20. Meade H. Caprines expressing genes of pharmaceutical applications. In *BMC Proceedings 2014 Oct (Vol. 8, No. 4, pp. 1-1).* BioMed Central. <https://doi.org/10.1186/1753-6561-8-S4-O32>
21. Mohai P, Kweon BS, Lee S, Ard K. Air pollution around schools is linked to poorer student health and academic performance. *Health Aff.* 2011 May 1;30(5):852-62. <https://doi.org/10.1377/hlthaff.2011.0077>
22. Jabeen F, Ali Z, Maharjan A. Assessing health impacts of winter smog in Lahore for exposed occupational groups. *Atmosphere.* 2021 Nov 20;12(11):1532. doi:10.3390/atmos12111532.
23. Xue S, Zhang B, Zhao X. Brain drain: The impact of air pollution on firm performance. *J Environ Econ Manage.* 2021 Oct 1;110:102546. <https://doi.org/10.1016/j.jeem.2021.102546>.
24. World Health Organization, 2014, 7 million premature deaths annually linked to air pollution. Geneva, Switzerland: WHO Media Center. https://www.who.int/phe/eNews_63
25. Saleem Z, Saeed H, Yousaf M, Asif U, Hashmi FK, Salman M, Hassali MA. Evaluating smog awareness and preventive practices among Pakistani general population: a cross-sectional survey. *IJHPE.* 2019 May 4;57(3):161-73. <https://doi.org/10.1080/14635240.2019.1576535>
26. Lahore, Pakistan Metro Area Population 1950-2022. (Lahore, Pakistan Metro Area Population 1950-2022. Available at <https://www.macrotrends.net/cities/lahore/population>.
27. Lahore Population Report, 2022. Available at <https://worldpopulationreview.com/world-cities/lahore>.

28. Paris Climate Change Agreement, 2016, Available online at: <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>
29. Su JG, Apte JS, Lipsitt J, Garcia-Gonzales DA, Beckerman BS, de Nazelle A, Texcalac-Sangrador JL, Jerrett M. Populations potentially exposed to traffic-related air pollution in seven world cities. *Environ Int.* 2015 May 1;78:82-9. doi:10.1016/j.envint.2014.12.007
30. WHO Global Conference on Health and Climate Change. 2021 <https://www.who.int/news-room/events/detail/2021/11/06/default-calendar/2021-global-conference-on-health-and-climate-change>
31. World Health Organization Report. Air Pollution. Geneva, Switzerland: World Health Organization.2019. <https://www.who.int/health-topics/air-pollution>
32. WHO Report May 2020. <https://www.who.int/health-topics/air-pollution>.
33. World Health Organization. First WHO Global Conference on Air Pollution and Health, 2018. <https://www.who.int/airpollution/events/conference/en/>
34. Manisalidis, I.,Stavropoulou, E.,Stavropoulos, A. and Bezirtzoglou,E., Environmental and Health Impacts of Air Pollution: A Review. *Front Public Health*, 2020; 8, 14. <https://doi.org/10.3389/fpubh.2020.00014>
35. WHO Report 2018 on United Nations Climate Change. First-ever Global Conference on Air Pollution and Health (<https://unfccc.int/news/first-ever-global-conference-on-air-pollution-and-health>)
36. Paris Climate Change Agreement, 2016, Available online at: <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>
37. Mishra S. Is smog innocuous? Air pollution and cardiovascular disease. *Indian Heart J.* 2017 Jul 1;69(4):425-9. <https://doi.org/10.1016/j.ihj.2017.07.016>.
38. Xie R, Wei D, Han F, Lu Y, Fang J, Liu Y, Wang J. The effect of traffic density on smog pollution: Evidence from Chinese cities. *Technol Forecast Soc Change.* 2019 Jul 1;144:421-7. <https://doi.org/10.1016/j.techfore.2018.04.023>.
39. Mannucci PM, Franchini M. Health effects of ambient air pollution in developing countries. *IJERPH.* 2017 Sep;14(9):1048. <https://doi.org/10.3390/ijerph14091048>
40. Yang LE, Hoffmann P, Scheffran J. Health impacts of smog pollution: The human dimensions of exposure *Lancet Planet. Health.* 2017 Jul 1;1(4):e132-3.. doi:10.1016/S2542-5196(17)30067-0
41. Brunekreef B, Holgate ST. Air pollution and health. *The lancet.* 2002 Oct 19;360(9341):1233-42. [https://doi.org/10.1016/S0140-6736\(02\)11274-8](https://doi.org/10.1016/S0140-6736(02)11274-8)