Public Perception Survey on Air Pollution in South Delhi

U Venkatesh, S Kumari, P Aparnavi, J Kishore, Mukesh Kumar, P Vandana

Department of Community Medicine, Vardhman Mahavir Medical College & Safdarjung Hospital, New Delhi.

Abstract

**Background:** According to a WHO study, 13 of the 20 most-polluted cities in the world are in India, which is more than half of the world’s most polluted cities. Delhi is at 11th position. Pollution in Delhi hit almost 30 times the WHO safe limit. On 8th Nov 2017, toxic smog enveloped Delhi, which alarmed the Indian Medical Association (IMA) to declare a public health emergency. They also advised citizens to stay indoors and schools to be shut. Air Quality Index (AQI) of neighboring Faridabad, Ghaziabad, Noida, and Gurgaon were also in the emergency category.

**Aim:** To assess perception on air pollution and the willingness to contribute to control air pollution among the general population of Delhi.

**Methodology:** A community-based cross-sectional study, in seven localities of South Delhi district of Delhi using simple random sampling. 384 adult members (>18 years) residing in the selected households for more than 6 months and who volunteered for the study were recruited. The sample size was calculated using Epi-info software version 7.2.2.2 (developed by CDC). A pre-tested semi-structured interviewer-administered questionnaire was used for data collection. Ethical clearance was obtained from administrative authorities and institutional ethical committee. Data was analyzed using a SPSS 21.

**Results:** Among 384 participants, 57.6% believed that the current air quality was worse than it was 5 years ago. People with high income (31.4%) perceived fewer symptoms due to current air quality. More men (61%) perceived air quality to be worse, but women perceived symptoms of air pollution more. Less-educated residents are the targetable population for improving environment. Regarding willingness to contribute for control of air pollution, all the positive questions received a median score of 4 or 5 (on a Likert scale of 1–5, where 1 is strongly disagree and 5 is strongly agree).

**Keywords:** Air Pollution, Perception

Introduction

Air pollution is the presence of gases, its mixtures and particulate matter in the ambient atmosphere that are generated due to activities of man in concentrations that interfere with human health or safety or with vegetation or animals or other environmental media, resulting in chemicals entering the food chain or drinking water and thereby causing additional source of human exposure. The direct effect of air pollutants on plants, animals and...
soil can influence the structure and function of ecosystem, including self-regulation ability, thereby affecting the quality of life.\(^1\) Major sources of air pollution include everything that burns like coal, kerosene, petrol, diesel, biomass, cow dung, and waste and non-combustion sources like dust.\(^2\)

The burden of air pollution is on a steep rise now. Air pollution has emerged as one of the top-10 risk factors for human health in India, and the Indian cities are increasingly exceeding the national ambient standards and the World Health Organization’s guidelines for air pollution criteria.\(^3\) Nearly 90% of air-pollution-related deaths occur in low and middle-income countries. Globally, nearly 3 million deaths a year are linked to exposure to outdoor air pollution and indoor air pollution can be just as deadly.\(^4\) It is estimated that about 1.6 billion people worldwide suffer from urban air pollution.\(^5\)

Considering only the urban areas where air pollution is monitored, more than 80% of people are exposed to air quality levels higher than the WHO cut-off limits.\(^6\) ICMR and PHFI state that after child and maternal malnutrition, which was India’s leading risk factor for health loss in 2016, air pollution was the second leading risk factor in India as a whole.\(^6\) According to a WHO study, 13 of the 20 most-polluted cities in the world are in India, which is more than half of the world’s most polluted cities. Delhi is at 11\(^{th}\) position. States most affected due to air pollution are Haryana, Delhi, Punjab, Bihar, Rajasthan, West Bengal and Uttar Pradesh. The states least affected by air pollution are Andhra Pradesh, Jharkhand, Maharashtra and Odisha. All cities, except for Coimbatore, exceed the PM10 annual standard of 100 μg/m\(^3\). Five out of 20 cities record more than three-times the annual standard.\(^2\) Pollution in Delhi hit almost 30 times the WHO safe limit. The AQI reached 1000 μg/m\(^3\) and is raising serious health concerns. On 8\(^{th}\) Nov 2017, Delhi was enveloped by toxic smog, alarming the Indian Medical Association (IMA) to declare a public health emergency, advising citizens to stay indoors, and for schools to be shut. CPCB and NRDC had declared pollution in Delhi as public health emergency. Air Quality Index (AQI) of neighboring Faridabad, Ghaziabad, Noida and Gurgaon were also in the emergency category.\(^7\) We must not lose the momentum in our fight for clean air and we must not lose sight of the fact that right to breathe is fundamental.\(^8\)

Previous studies have shown that both objectives (scientifically measured), i.e., environmental pollution and perceived levels of pollution are important predictors of self-reported health. Knowledge and attitude towards air pollution need to be assessed, as lack of knowledge accelerates the risk in times of emergency due to air pollution and also is partially responsible for increasing burden of air pollution. Willingness of people to actively participate is the key step to curb this threat. However, even in areas with extremely high subjective levels of pollution, people are often not concerned about pollution. Unless there is a sustained effort to address the causes of air pollution at its source, the problem will only exacerbate over time.\(^7\) Though there has been a recent upsurge of research in the field of environmental events with more focus on air pollution, the studies on the public perception of air pollution and willingness to pay for its control measures are very limited. Therefore current research related to air pollution has mainly focused on people’s perception about the quality of air, knowledge of people about causes of air pollution and their attitude towards steps that can be taken to combat air pollution. With this background knowledge, the current study aims to assess perception of general population on air pollution in Delhi and to assess the willingness to contribute to control air pollution.

**Materials and Methodology**

A community-based cross-sectional Study was conducted in South Delhi district of Delhi, northern India, from 1\(^{st}\) January to 28\(^{th}\) January 2018 in seven localities using simple random sampling. In the selected localities, list of all households was prepared to provide the sampling frame and Individual household was selected by systematic random sampling. Any adult member (218 years) residing in a selected household for more than 6 months and volunteering for interview was recruited in the study to complete a predetermined sample size of 384 participants. The sample size was calculated using Epi-info software version 7.2.2.2 (Developed by CDC), the population of south Delhi was taken into consideration, i.e., 2.73 million (Census 2011), with 50% prevalence and 5% acceptable margin of error and 95% confidence interval, the calculated sample size was 384. A preformed, pre-tested, semi-structured, interviewer-administered questionnaire was used for data collection. The data was entered in Microsoft Office Excel sheet and analysis was done using a licensed version of SPSS 21. Descriptive analysis was done by calculating proportions, mean, and standard deviation. Differences between proportions were assessed using Chi-square test. Ethical clearance was obtained from the administrative authorities and from the Institutional Ethics Committee. Written voluntary informed consent was taken from all the participants after explaining the purpose of the study.

**Results**

A total of 384 participants were included in the study. Majority of the participants were in 18–30 years age group with 319 (83%) people, followed by 58 (15.1%) in 31–50 years age and 7 (1.8%) in more than 51 years age group. Study group had 221 (57.5%) males and 163 (42.4%) females. People who were illiterate or had not completed primary school were categorized as Education Class (EC) 1 and they were 69 (17.9%) and 44 (11.4%) respectively. Similarly people who went to secondary school or graduates were categorized as Education Class (EC) 2 and they were 164 (42.7%) and 107 (27.8%) respectively. 145 were working
population and contributed 37.6% and 239 (62.4%) of them were not working. Out of the 145 working people who earned less than Rs 30,000 month were categorized as Income category (IC) 1 and 31 (21.3%) people who earned more than Rs 30,000 month were under IC 2; for calculation purposes people who had no income were also included in the IC 1.

Table 1. Sociodemographic Details of the Participants

| Sociodemographic Details | Frequency (%) |
|--------------------------|--------------|
| Age                     |              |
| 18–30 years             | 319 (83)     |
| 31–50 years             | 58 (15.1)    |
| >51 years               | 7 (1.8)      |
| Gender                  |              |
| Male                    | 221 (57.5)   |
| Female                  | 163 (42.4)   |
| Education               |              |
| Illiterate (EC1)        | 69 (17.9)    |
| Up to Primary School (EC1) | 44 (11.4)  |
| Up to Senior Secondary (EC2) | 164 (42.7) |
| Graduate and above (EC2) | 107 (27.8)  |
| Occupation              |              |
| Working                 | 145 (37.6)   |
| Non-working             | 239 (62.4)   |
| Average monthly income of working population (n=145) | |
| Under 5k (IC1)          | 38 (26.2)    |
| 5k–10k (IC1)            | 40 (27.5)    |
| 10k–30k (IC1)           | 36 (24.8)    |
| 30–50k (IC2)            | 23 (15.8)    |
| Above 50k (IC2)         | 8 (5.5)      |

Out of 384 participants, 221 (57.6%) perceived that air quality had become worse but 163 (42.4%) perceived it to be same or better. When interviewed about the causes of air pollution as believed by the people, highest number of people (65.8%) believed that motor vehicles contribute to air pollution and the second leading cause was believed to be construction works by 42% of the people, followed by industrial sources 41%, burning of waste 38.5%, population growth 31.5%, pollution from nearby states 28.12%, use of air conditioner 27.8%, smoke of cigarette/bidi/tobacco 26%, waste disposal 22.9%, household cooking 17.9% and other causes such as fire crackers, etc., were believed to be cause of air pollution by only 11.9% of the study subjects. Scoring was done for answers about knowledge on causes of air pollution and the mean score was 15.79, with SD of 2.006. Score within 2SD (11.778–17.796) was considered average knowledge, <2SD (11.778) as poor knowledge, and >2SD (17.796) as good knowledge.

Table 2. Association of Knowledge of People about Causes of Air Pollution with Their Educational Status and Gender

| Sociodemographic Details | Average Knowledge Frequency (%) | Good Knowledge Frequency (%) | P Value* |
|--------------------------|---------------------------------|-----------------------------|----------|
| Education                |                                 |                             |          |
| EC1                      | 97 (85.8%)                      | 16 (14.2%)                  | 0.279    |
| EC2                      | 220 (81.1%)                     | 51 (18.8%)                  |          |
| Gender                   |                                 |                             |          |
| Male                     | 186 (84.2%)                     | 35 (15.8%)                  | 0.323    |
| Female                   | 131 (80.4%)                     | 32 (19.6%)                  |          |
| Total                    | 317 (82.6%)                     | 67 (17.4%)                  |          |

*Chi-square test
It was found that 363 (95%) of the total study population felt that pollution had affected their life. Only 21 (5.4%) said that they were not affected at all. The questionnaire included a multiple-choice question to ask the symptoms perceived by people due to air pollution. Breathlessness was the symptom perceived by the largest number of people 183 (50.4%), followed by irritation to ear/nose/throat 178 (49%), 154 (42.4%) experienced episodes of asthma, 131 (36%) had symptoms of poor vision and (4.4%) 16 felt they were depressed because of air pollution.

![Figure 1. Distribution of Symptoms Perceived due to Air Pollution](image1)

Similarly, when asked about the change in lifestyle required because of air pollution, 172 (47.3%) felt they had to restrict outdoor activities, 100 (27.5%) felt they had to do more to stay healthy and 93 (25.6%) wanted to move to some other place because of air pollution and 92 (25.3%) felt they required more skin care because of air pollution.

![Figure 2. Distribution of Perceived Changes Required in Lifestyle due to Air Pollution](image2)

The questions on symptoms perceived due to air pollution and changes in lifestyle required due to air pollution were scored; 50th percentile of the score was 15. Therefore, those who scored above 15 were considered to be affected by air pollution.
People's concern on each of the following pollutions was assessed and a Likert-scale scoring was given from 1 to 7, with 1 being least concerned and 7 as the highest concern. The median score for each pollution was taken and plotted in a radar chart.

![Radar chart showing concern levels for various pollutions](image)

**Figure 3. Median Score on Concern about Each Type of Environmental Pollution**

Action that is taken by people to combat air pollution was asked as an open-ended question, for which 253 people (63%) said they use masks, 159 (39.6%) use carpooling, and 131 (32.6%) use public transport as a measure to combat air pollution. Among those who perceived air quality to be worse, sociodemographic differences were analyzed and the results are as follows.

| Sociodemographic Details | Affected by Air Pollution (74) (%) | P Value*
|--------------------------|-----------------------------------|--------
| Income                   |                                   |        |
| IC 1                     | 30 (34.1%)                        | 0.003  |
| IC 2                     | 44 (18.6%)                        |        |
| Age                      |                                   |        |
| 18–30 years              | 57 (21.2%)                        | 0.184  |
| 30–50 years              | 16 (32.7%)                        |        |
| >51 years                | 1 (14.3%)                         |        |
| Gender                   |                                   |        |
| Male                     | 39 (21.4%)                        | 0.516  |
| Female                   | 35 (24.5%)                        |        |

*Chi-square test

| Sociodemographic Details | Perceived Quality to be Worse (%) | P Value*
|--------------------------|-----------------------------------|--------
| Age                      |                                   |        |
| 18–30 years              | 189 (59.2%)                       | 0.234  |
| 30–50 years              | 28 (47.5%)                        |        |
| >51 years                | 4 (57.1%)                         |        |
| Gender                   |                                   |        |
| Male                     | 137 (61.7%)                       | 0.046  |
| Female                   | 84 (51.5%)                        |        |
| Income                   |                                   |        |
| IC 1                     | 65 (58.6%)                        | 0.749  |
| IC 2                     | 156 (56.8%)                       |        |

*Chi-square test

Level of concern on different pollutions like air pollution, drinking water pollution, surface water pollution, garbage and solid waste, global warming and climate change, loss of green areas in city, and unsafe food was assessed. Total score for all pollution was in the range of 7–49. 50th percentile for concern was 39. Thus people who scored more than 50th percentile were considered more concerned and who scored equal to or less than 39 were categorized as less concerned.
People were interviewed as to how much they were willing to contribute to the measures that could be taken to control air pollution, if those measures would have them to spend a little money or time for it. The responses were scored on a Likert scale from 1 to 5 where 1 was strongly disagree and 5 was strongly agree. The median score for each question was calculated, when asked about willingness to fine polluting companies even if it puts some jobs at risk the score was 5. The median score for the question ‘power stations and factories should switch to cleaner process even if consumer bills and prices have to go up’ was 4 and the score for ‘government should do more to promote and encourage a better environment even if our taxes have to go up slightly’ was 4. Similarly, the median scores for ‘police should stop and check car emissions more frequently even if it causes traffic delays’ was 4, for the question ‘improving the environment is the responsibility of every citizen’ was 5, for ‘recycling program should be put in place and promoted across the whole city’ was 5, for the question ‘I am actively involved in cleaning up the environment’ was 3, and for ‘If I knew how to better contribute to a cleaner environment, I would take action’ was 5. The median score was only 2 for ‘the pollution is out of my control and I cannot do anything to change it’ and again a low score of 2 was observed for the question ‘I do not see pollution as a problem’.

![Table 5. Association between Concern on Level of Pollution and Sociodemographic Patterns](image)

| Sociodemographic Details | Less Concerned | More Concerned | P Value* |
|--------------------------|----------------|---------------|----------|
| Gender                   |                |               |          |
| Male                     | 131 (59.0%)    | 91 (41.0%)    | 0.002    |
| Female                   | 70 (42.9%)     | 93 (57.1%)    |          |
| Education                |                |               |          |
| EC 1                     | 77 (68.1%)     | 36 (31.9%)    | <0.001   |
| EC 2                     | 124 (45.6%)    | 148 (54.4%)   |          |

*Chi-square test

*1–5 are Likert scale scores of attitude towards control measures with 1 as strongly disagree and 5 as strongly agree

**Discussion**

Only 57.6% perceive that air quality has become bad, whereas in our study setting, Delhi, the pollutants in air are on a steep rise as reported by CPCB that change PM$_{10}$ was 60 µg/m$^3$ in 2009 to 228 mcg/m$^3$ in 2015. A draft report prepared by the Indian Institute of Technology, Kanpur, sponsored by the Delhi government and the Delhi Pollution Control Committee, revealing the extent to which various sources contribute to air pollution in the city, identifies and classifies sources of pollution such as industry, traffic, power plants, and small-scale industries for the period from November 2013 to June 2014. According to this study, the main source of air pollution was road dust (56%), followed by industrial
source (10%), vehicles are in the fourth place with 9% and construction work holds only 2% but in our study, motor vehicles, construction and industrial sources were the first three causes perceived in order. This difference could have come because the former study was done to actually analyze the source of pollution whereas our study only ranks sources based on people’s knowledge and beliefs about air pollution. The general public may perceive the health risks of air pollution differently on account of various demographic characteristics. For example, women usually perceive higher levels of air pollution risk than men; the results in our study showed that more men perceived air quality to be worse and the results were statistically significant. This may be due to exposure to outdoor pollutants during peak hours of traffic. Kim et al. have indicated that young people are more sensitive to air pollution risks, while the elderly pay more attention to health and safety.

Accordingly, our study also showed that more people of 18–30 years and >50 years perceive bad air quality than middle-aged people though these results are not statistically significant. But in contrast to our results, Forsberg et al. have discovered a higher risk perception of air pollution among middle-aged people. Further to that point, individuals with higher levels of education and income are expected to be more concerned about air pollution, as these factors could provide them with resources to understand the impacts of air pollution on their lives. Conversely, Geelen et al. found that people with lower income and education levels might have more complaints about air pollution. Our study also showed that people with higher education are more aware of the causes of air pollution (not statistically significant) and a significant finding that people with lower income are more affected by air pollution; this can be due to unavailability of protective measures to low-income people. In addition, air quality perception could also be influenced by psychological and physical experiences, health and lifestyle factors (e.g., time spent outdoors, as well as temperature variations and thermal sensations during different seasons). These factors were not analyzed in our study. Examining individual perception towards air pollution could reflect the social dimensions and circumstances under which people understand pollution. Unfortunately, the study methodology suffered from a few drawbacks. Delhi population being heterogeneous one, inconsistency in certain factors like literacy rate was found in the study and it would have been more ideal to have more varied spatial, employment and demographic data for unique insights into perception on air pollution. Moreover, being a cross-sectional study, the exposure and outcome were measured at the same time and so a temporal association could not be made. In willingness to contribute for control of air pollution, all the positive questions received a median score on the higher end of Likert scale, whereas questions like ‘pollution is out of my control’ received a lower median score, thus indicating people are more willing to contribute for the control of air pollution even if it was at their cost.

**Conclusion**

A total of 384 individuals of age >18 years participated in the survey, among which 57.6% of respondents believed that the current air quality was worse than it was 5 years ago. People with high income (31.4%) perceived lesser symptoms due to current air quality compared to people with lower income. More men (61%) perceived air to be of worse quality than women, but more women perceived symptoms due to air pollution more than men. Participants strongly agreed that polluting companies should be fined and police should check car emissions more frequently. Interestingly, 13.8% participants do not see pollution as a problem. There was relatively high awareness rate, strong health protection consciousness, and high enthusiasm for air pollution control measures among the study population. Less-educated residents are the targetable population for improving environment.

**Recommendations**

To reduce the burden of air pollution, measures like using public transport (bus and metro), carpooling, walking for short distances instead of using private vehicle, keeping automobiles well-tuned and maintained following updated BS-IV norms, and use of automobile vehicles with cleaner fuels (CNG) should be started from individual level. However, collective responsibility of the society and its contributions play more important role in air pollution control measures. Government should educate people about the peak period of air pollution in the city (smog at Diwali time), explain the importance of preventive measures such as use of N-95 masks to combat the situation, encouraging tree plantation in the society and help in understanding the concept of reduce, reuse and recycle and emphasize on use of clean energy sources.

**Conflict of Interest:** None

**References**

1. Europe WHORO. Air Quality guidelines for Europe. 1987 [cited 2018 Apr 26]; Available from: http://apps.who.int/iris/handle/10665/107364.
2. India – Air Pollution Knowledge Assessment (APnA) city program. Available at http://www.urbanemissions.info/wpcontent/uploads/apna/docs/apna_program_summary_booklet.pdf. Last accessed 17/3/2018.
3. India – Air Quality Forecasts [Internet]. [cited 2018 Apr 26]. Available from: http://www.urbanemissions.info/india-air-quality-forecasts/.
4. State of Global Ai, A special report on global exposure to air pollution and its disease burden. Available at https://www.stateofglobalair.org/sites/default/files/SOGA2017_report.pdf. Last accessed on 16/3/2018.
5. State of Global Air [Internet]. State of Global Air. [cited 2018 Apr 26]. Available from: https://www.stateofglobalair.org/.
6. India State-Level Disease Burden Initiative [Internet]. [cited 2018 Apr 26]. Available from: https://www.phfi.org/news-and-events/highlights/1792.
7. November 08, Jaiswal 2017 Anjali. Air Pollution Emergency in Delhi – #DelhiSmog [Internet]. NRDC. [cited 2018 Apr 26]. Available from: https://www.nrdc.org/experts/anjali-jaiswal/air-pollution-emergency-delhi-delhismog.
8. EPCA releases Report Card on Delhi’s air pollution [Internet], [cited 2018 Apr 26]. Available from: https://www.cseindia.org/epca-releases-report-card-on-delhis-air-pollution-8502.
9. Center for pollution control board, Delhi an analysis. Available at http://cpcb.nic.in/NGT/Air_Quality_data_Delhi-NCR_December_2017.pdf . Last accessed on 15/3/2018.
10. Seo MG, Barrett LF. Being emotional during decision making – good or bad. An empirical investigation. J Acad Manag 2007 Aug; 50(4): 923-40.
11. Kim M, Yi O, Kim H. The role of differences in individual and community attributes in perceived air quality. Sci Total Environ 2012 May 15; 425: 20-26.
12. Fischer GW, Morgan MG, Fischhoff B et al. What risks are people concerned about. Risk Analysis 1991 Jun 1; 11(2): 303-14.
13. Forsberg B, Stjernberg N, Wall S. People can detect poor air quality well below guideline concentrations: A prevalence study of annoyance reactions and air pollution from traffic. Occup Environ Med 1997 Jan; 54(1): 44-48.
14. Williams ID, McCrae IS. Road traffic nuisance in residential and commercial areas. Sci Total Environ 1995 Jul 8; 169(1-3): 75-82.
15. Egondi T, Kyobutungi C, Ng N et al. Community perceptions of air pollution and related health risks in Nairobi slums. Int J Environ Res Public Health 2013 Oct; 10(10): 4851-68.
16. Jacquemin B, Sunyer J, Künzli N. Author’s response: Linking particulate matter and sulphur concentrations to air pollution annoyance: problems of measurement, scale and control. Int J Epidemiol 2007 Aug; 36(4): 823-24.
17. Geelen LMJ, Souren AFMM, Jans HWA et al. Air pollution from industry and traffic: Perceived risk and affect in the Moerdijk Region, The Netherlands. Hum Ecol Risk Assess Int J 2013 Nov 2; 19(6): 1644-63.
18. Semenza JC, Wilson DJ, Parra J et al. Public perception and behavior change in relationship to hot weather and air pollution. Environ Res 2008 Jul; 107(3): 401-11.
19. Klaeboe R, Kolbenstvedt M, Clench-Aas J et al. Oslo traffic study - part 1: An integrated approach to assess the combined effects of noise and air pollution on annoyance. Atmospheric environment 1994; 2000; 34(27): 4727-36.
20. Brody SD, Peck BM, Highfield WE. Examining localized patterns of air quality perception in Texas: a spatial and statistical analysis. Risk Anal Off Publ Soc Risk Anal 2004 Dec; 24(6): 1561-74.
21. Nikolopoulou M, Baker N, Steemers K. Thermal comfort in outdoor urban spaces: understanding the human parameter. Solar Energy 2001 Jan 1; 70(3): 227-35.
22. Dorizas PV, Assimakopoulos MN, Santamouris M. A holistic approach for the assessment of the indoor environmental quality, student productivity and energy consumption in primary schools. Environ Monit Assess 2015 May; 187(5): 259.
23. Zhang H, Ares E, Pasut W. Air temperature thresholds for indoor comfort and perceived air quality. Build Res Inf 2011 Apr 1; 39(2): 134-44.
24. Künzli N, Kaiser R, Medina S et al. Public-health impact of outdoor and traffic-related air pollution: A European assessment. Lond Engl.: Lancet 2000 Sep 2; 356(9232): 795-801.

Date of Submission: 2018-05-01
Date of Acceptance: 2018-05-03