***Impact of Air Pollution on Public Health – An Observational Study***


**Principal Investigator**

**Dr. Nandini Sharma**
**Dean**
**Maulana Azad Medical College,**
**New Delhi**

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Scientist D
Delhi Pollution Control Committee

**Dr. Ekta Arora**
Senior Resident
Dept. of Community Medicine
Maulana Azad Medical College
New Delhi

## Project Staff

**Field Investigators**

Mr. Surender
Ms. Sonia Dwivedi

**Data Entry Operator:**

Ms. Minakshi
Ms. Payal

**Report Compiled by-**
Dr. Ekta Arora

Under supervision of-
Dr. Nandini Sharma
Dr. Pragya Sharma

**Acknowledgement:**

**We bow with reverence, all humility and gratitude to thank The Almighty**

**for giving the opportunity to undertake this work and**

**the ability to successfully complete it.**

We express our sincere thanks to Delhi Pollution Control Committee, Department of Environment, Government of NCT of Delhi, for giving this opportunity to us and providing financial support.It is a matter of great pride and privilege for us for having worked under the able guidance of senior officials of DPCC. We are grateful for their scientific advice and knowledge and many insightful discussions and suggestions. Their meritorious supervision, everlasting inspiration, and invaluable encouragement at every step, helped us a lot.

We express our profound indebtedness and deep gratitude to Dr. Suneet Jindal, MD Clinical Pharmacology for his unconditional help, guidance, and fervent personal interest from the very inception of the study. His valuable insights and statistical inputs have brought light to the study. We are thankful to Senior Residents from the department of Community Medicine, MAMC- Dr. Saurav Basu, Dr. Yamini M, Dr. Nidhi Budh, Dr. Samar Hossain & Dr. Kajok for their support and ever-ready help at every step during this study. We would also like to thank Dr Bharat Nag, ILBS and Junior Residents from MAMC especially Dr Rohit for their friendly support and help during study.

Not to forget the names of the hospitals and their administrators who provided us the permission to work in their premises and collect data from their medical records sections. We pay a deep gratitude to all the staff in the wards and medical record sections in the hospitals selected. The investigators are deeply indebted to the patients for their cooperation from where the data has been collected in the hospitals.

The contribution of the community and the participants who volunteered to be a part of the study is immense and the completion of the study would never have been possible without their support. We extend our deep gratitude towards their support.

In the end, we would like to thank all those whose names are not mentioned, but who have directly or indirectly contributed to the completion of this mammoth task.

Project Investigators

## **Executive Summary**

An observational study was carried out to determine the relationship of outdoor air quality with the rate of admissions for cardiac and respiratory conditions and to find the impact of air pollution in restricting the routine activities among healthy adults in the community. The morbidity and mortality data were collected from sampled hospitals for a period of fifteen months starting from April, 2019. The rate and trends of the cardio-respiratory morbidity and mortality were corroborated with the change in values of Air Quality Index (AQI), PM2.5and Ozone levels from the information available on the Central Govt (CPCB) and Delhi Government, DPCC web portal. Community based data (collected by using a pre-designed and pre-tested Questionnaire) on Restriction of activity, perceived stress, awareness and interventions required for improving the air quality amongst the inhabitants of all the eleven districts of Delhi was collected. Permission from the sampled hospitals was taken and due permission was taken from Institutional ethics Committee. Descriptive statistics and correlation among emergency admissions and air pollutants was analyzed using Microsoft Excel. For community survey, Categorical data was expressed in frequency and proportions. Appropriate statistical tests have been applied to find out association between different variables.

## OBJECTIVES

1. To determine the relationship of outdoor air quality with the rate of admissions for cardiac and respiratory conditions.
2. To find the impact of air pollution in restricting the routine activities among healthy adults in the community.

## Detailed Report

### 1. Recruitments:

Interview was conducted for the recruitment of Field Investigators (FIs) and Data entry operator cum Statistical Assistant on 26th February 2019. Two Field Investigators were selected, and they joined on 1st April, 2019.

One Data entry Operator (DEO) was recruited, and she joined on 15th March 2019. Following her resignation in March2020, another DEO was recruited from 1st April, 2020.

### 2. Training and Orientation

Training of the Field Investigators was done for the initial period wherein they were acclimatized to the hospital and community settings and were oriented towards communication skills and filling of proforma.

### 3. Sampling:

**Hospital Survey:** Delhi has been divided into 5 zones (North, South, East, West and Central). 5 hospitals were included in the sample representing each zone to collect data for cardiopulmonary illnesses i.e. One hospital each in Central, East, West, North and South Zones of Delhi.

a. Lok Nayak Hospital in Central

b. Deen Dayal Upadhyay in West

c. Baba Saheb Ambedkar in North

d. Guru Teg Bahadur (GTB) Hospital in East

e. Madan Mohan Malviya (MMM) in South of Delhi

Lal Bahadur Shastri hospital was also sampled in the study from October onwards due to administrative challenges being faced in data collection in Guru Teg Bahadur Hospital.

All hospital admissions for the cardio-pulmonary diseases during the designated period i.e., fifteen months were studied for trends and their association with the quality of air. This information was gathered from the hospital records. The admission and mortality rates were analyzed over the period for trends in relation to the change in air quality with reference to Air Quality Index(AQI), Particulate Matter and Ozone levels.

The rate and trends of the cardio-respiratory morbidity in terms of hospital admissions
has been corroborated with the change in values of Air Quality Index (AQI), PM 2.5 and Ozone levels from the information available on the Central Govt (CPCB) and Delhi Government, DPCC web portal.

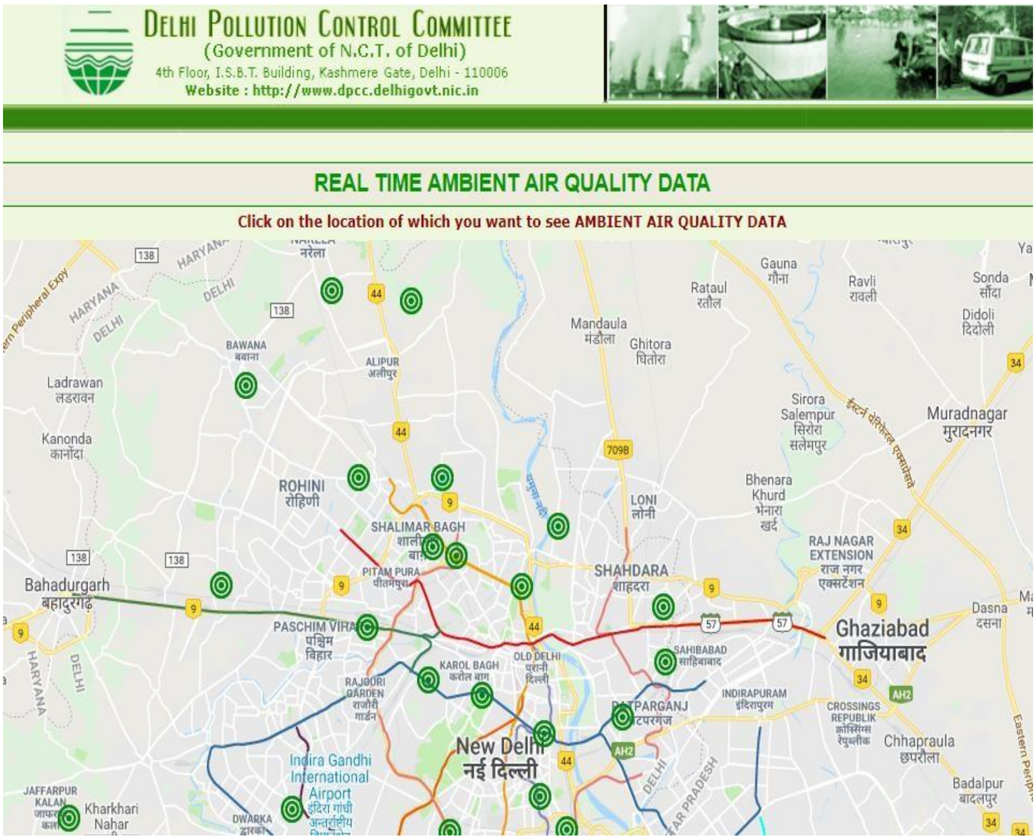
**Community Survey:**

The National Capital Territory of Delhi covers an area of 1,484 $km^2$ of which 783 $km^2$ is designated rural, and 700 $km^2$ urban therefore making it the largest city in terms of area in the country.

There are eleven administrative districts in the National Capital Territory of Delhi in India.


Two areas were selected from each district – one where DPCC/CPCB monitoring station is located and other at 5-15kms from the former.

# Map showing DPCC monitoring stations



**Below is the list of the sampled areas in the 11 districts.**

| | District | Community A (AQI Monitoring Station Area) | Community B (Approx. 5-15 kms from A) |
|---|---|---|---|
| 1. | Central Delhi | Pusa Road, Karol Bagh | Daryaganj |
| 2. | New Delhi | Maj. Dhyan Chand National Stadium Area | Connaught Place |
| 3. | North Delhi | Civil Lines | Kashmere Gate |
| 4. | North East Delhi | Sonia Vihar | Gokalpuri |
| 5. | North West Delhi | Pooth Khurd, Bawana | Barwala |
| 6. | Shahdara | IHBAS, Dilshad Garden | Ganga Vihar |
| 7. | West Delhi | Punjabi Bagh | Janakpuri |
| 8. | East Delhi | Anand Vihar | Preet Vihar |
| 9. | South Delhi | JLN Stadium Area | Lajpat Nagar |
| 10. | South West Delhi | Dwarka, Sec 8 | Mehrauli |

| | | | |
|---|---|---|---|
| 11. | South East Delhi | ----- | Kalkaji |

**METHODOLOGY**

Study design: Observational Study

Study Site and Population:

1. **For Morbidity and Mortality:** The data from Indoor and Emergency admissions were collected from one hospital each in Central, East, West, North and South areas of Delhi. Lok Nayak Hospital in Central, Deen Dayal Upadhyay in West, Baba Saheb Ambedkar in North, Guru Teg Bahadur (GTB) Hospital in East and Madan Mohan Malviya (MMM) in South of Delhi were the hospitals sampled for collection of morbidity and mortality related data.

   The morbidity and mortality data were collected for a period of fifteen months starting from April, 2019 to study and analyze the trends of cardio-respiratory morbidity due to change in the quality of air with climate change over the year.

   The rate and trend of the cardio-respiratory morbidity in terms of hospital admissions were corroborated with the change in values of Air Quality Index (AQI), PM (10 & 2.5) and Ozone levels from the information available on the Central Govt (CPCB) and Delhi Government, DPCC web portal. The correlation and trend analysis for mortality could not be done since air quality was not mentioned as an underlying cause of death in the hospital records.

2. **To study the perceived health effects of the change in air quality -** Community based data (collected by using a pre-designed and pre-tested Questionnaire) on Restriction of activity, perceived stress, awareness regarding cause and perceived interventions required for improving the air quality amongst the inhabitants of all the eleven districts of Delhi was collected.

Study Population: For the self-perceived health effects, Restriction of activity, perceived stress, awareness and interventions required for improving the air quality, sample from population aged more than 18 years residing in all the Eleven districts of Delhi was sampled.

**Sample Size:**

For Hospital Based Study: All patients meeting the inclusion criteria during the study period were included.

For Community based Study: Sample size has been calculated to be 980 using formula $4pq/n^2$ With Prevalence used is 31% (Respiratory diseases associated with air pollution) * at an allowable error: 10%.

*Shahi AM, Omraninava A, Goli M, Soheilarezoomand HR, Mirzaei N. The Effects of Air Pollution on Cardiovascular and Respiratory Causes of Emergency Admission. Emergency. 2014;2(3):107–14

Considering the Design Effect of 2:

Sample size: 980*2 = 1960

**Sampling Strategy**:

Out of 11 districts in Delhi (2011 census), two areas were randomly selected from each district. One area in each district was chosen in the vicinity of the CPCB/DPCC monitoring station and the other more than 5-15 kms away from it.

For selecting the households in the sampled areas, systematic random sampling procedure at the time of survey was used. The number of households were selected in proportion to the population (DLHS data) of each district.

For systematic random sampling, every nth house was visited in the selected area as n= (total number of houses in the area/ total number of houses to be taken from that area). For this, list of houses was procured from dispensary/ASHA of the area beforehand.

Also, data was collected using a patient interview schedule and predesigned questionnaire. One-month recall was used to fill the questionnaire. Thus, seasonal impact of Air Pollution was also assessed. People in the community were provided health education for their protection from increasing hazards of air-pollution. Also, if required, people were counselled and referred to higher centers for further management.

Exclusion criteria

Patients admitted due to any other unrelated etiology like genetic factors.

Study Outcomes:

1. Correlation between cardio-respiratory admissions and air quality:
    - Levels of AQI, Particulate Matter and Ozone in Ambient air
2. Proportion of patients admitted with cardio-pulmonary illnesses attributable to air pollution.
3. Proportion of people with:
    - Awareness regarding air-pollution and its causative factors
    - Self-perceived stress using Perceived Stress Score (PSS)
    - Insights into strategies and interventions required to improve Air Quality
4. For assessing the effect of any public health intervention done to reduce Air Pollution, the baseline data generated through this study can be used for evidence generation

Statistical analysis: Descriptive statistics and correlation among emergency admissions and air pollutants were analyzed using Microsoft Excel. For community survey, Categorical data was expressed in frequency and proportions. Appropriate statistical tests have been applied to find out association between different variables.

## 4. Permission from the Hospitals:

Permission was sought from the Medical Director/Medical Superintendent of various hospitals sampled for the study to collect data from the Medical Records Department and Medicine and Paediatrics wards for cardiopulmonary cases. All the concerned authorities were approached, and the study protocol was explained to them.

Field Investigators were then oriented towards hospital setup. They were acclimatized with the functioning of Medical Records Department. Subsequent Visits were made by the Project Investigators to assess the functioning of the staff.

*Please find attached the Permission letters from various sampled hospitals.

No-585/19/PSM

Department of Community Medicine
Maulana Azad Medical College
New Delhi-110049

To
The Head of Department
Department of Medicine
Lok Nayak Hospital
New Delhi

Sub: Permission for Data collection in Medicine wards in Lok Nayak hospital for a study titled "Impact of Air Pollution on Public Health-An Observational Study".

Sir

A study titled "Impact of Air Pollution on Public Health – An Observational Study" is being carried by Department of Community Medicine, Maulana Azad Medical College in collaboration with Delhi Pollution Control Board (DPCC), Govt. of Delhi.

For this study, Field investigators will visit the hospital and collect data regarding cardiopulmonary patients from Medical Record Division/IT/HMIS and also from patients admitted in medicine and pediatrics wards with cardiopulmonary illness.

You are requested to kindly direct the relevant sections of your department to cooperate with our field investigators in Data Collection.

Please find attached the copy of approval letter from Medical Superintendent of the hospital.

Warm Regards

19/6/19

डा. नंदिनी शर्मा / Dr. NANDINI SHARMA
Director Professor & HOD
Department of Community Medicine
Maulana Azad Medical College

Dr. Nandini Sharma (PI)
Dir. Professor & Head
Department of Community Medicine
Maulana Azad Medical College, New Delhi -110002

may be allowed

Permitted to collect relevant data with consent from patient or their relatives

20/6/19

Dr. SURESH KUMAR
Director Professor
Deptt. of Medicine
MAMC & L. N. Hospital
New Delhi-110002

21/7/19

Dr. R.S. AHLAWAT
Director Professor & HOD
Department of Medicine
Maulana Azad Medical College
& Associated L.N. Hospital
Govt. of NCT of Delhi
New Delhi-110002

Circulate to all Unit Heads

**DR. BABA SAHEB AMBEDKAR HOSPITAL**
**(GOVT. OF NCT OF DELHI)**
**PLANNING BRANCH.**

**Sub: - Regarding Permission for data collection for the study titled Impact of Air Pollution on Public health-observation study.**

With reference to the approval of the competent authority (copy enclosed) on the subject cited above. You are requested to kindly permit the Field Investigator carrying ID Card of Department of Community Medicine, Maulana Azad Medical College to collect the data from your department for further few months.

(Dr. Meenakshi Sidhar)
M.O(I/C),MRD

Enclosure-As above mentioned.

No. 7(33)/BSAH/MRD/2017/Admn. Mtr. 12535 Dated: 9/5/2019

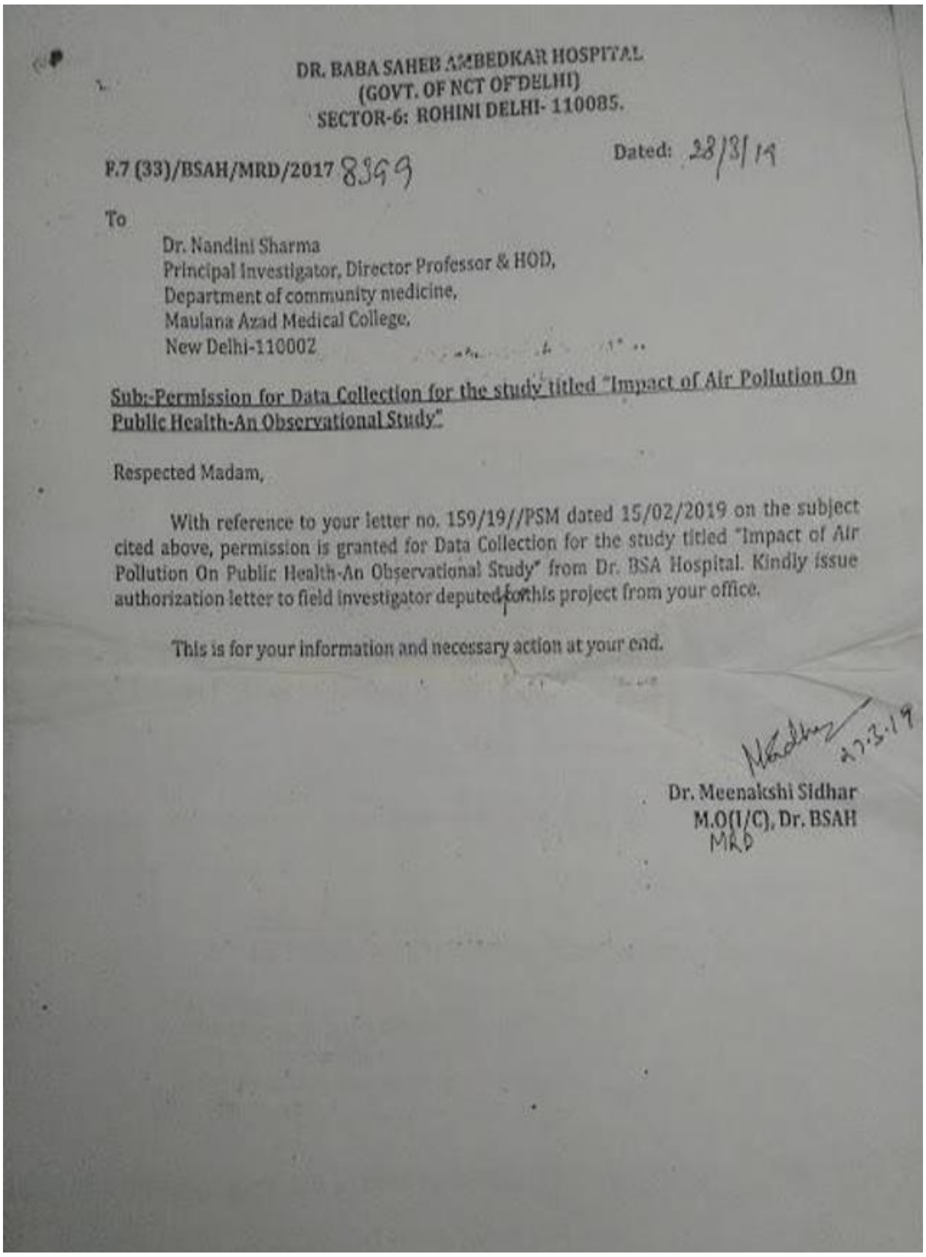
To,

1. H.O.D (Medicine).
2. H.O.D (Peads).

Permit to inspection

09/5/19

Dr. HARENDER KUMAR
MD (Medicine)
HOD & Senior Specialist
B.S.A. Medical College & Hospital
...110085



DR. BABA SAHEB AMBEDKAR HOSPITAL
(GOVT. OF NCT OF DELHI)
SECTOR-6: ROHINI DELHI- 110085.

F.7 (33)/BSAH/MRD/2017 8399

Dated: 28/3/19

To

Dr. Nandini Sharma
Principal Investigator, Director Professor & HOD,
Department of community medicine,
Maulana Azad Medical College,
New Delhi-110002

**Sub:-Permission for Data Collection for the study titled "Impact of Air Pollution On Public Health-An Observational Study"**

Respected Madam,

With reference to your letter no. 159/19//PSM dated 15/02/2019 on the subject cited above, permission is granted for Data Collection for the study titled "Impact of Air Pollution On Public Health-An Observational Study" from Dr. BSA Hospital. Kindly issue authorization letter to field investigator deputed for this project from your office.

This is for your information and necessary action at your end.

27.3.19

Dr. Meenakshi Sidhar
M.O(I/C), Dr. BSAH
MRD

D. No. ...........
Date 30/9/19
L.B.S. Hospital, Delhi-91

Department of Community Medicine
Maulana Azad Medical College
New Delhi-110049!

No. 894/PSM

To
The Medical Superintendent
Lal Bahadur Shastri Hospital
New Delhi

Sub: Permission for Data collection in LBS hospital for a study titled "Impact of Air Pollution on Public Health-An Observational Study".

Madam,

A study titled "Impact of Air Pollution on Public Health – An Observational Study" is being carried by Department of Community Medicine, Maulana Azad Medical College in collaboration with Delhi Pollution Control Board (DPCC), Govt. of Delhi.

For this study, Field investigators will visit the hospital and collect data regarding cardiopulmonerry patients from Medical Record Division/IT/HMIS and also from patients admitted in medicine and pediatrics wards with cardiopulmonary illness.

Schedule for Field Investigators:

| | | |
|---|---|---|
| Mr. Surender | Medicine/Peds Ward/MRD | Monday & Wednesday |
| Ms. Sonia Dwivedi | Medicine/Peds Ward/MRD | Tuesday & Thursday |

You are requested to kindly direct the relevant sections of your hospital to cooperate with our field investigators in Data Collection.

Please find attached herewith the copy of I-cards of the field investigators.

Warm Regards

27/9/19

Dr. Nandini Sharma (PI)
Dir.Professor & Head
Department of Community Medicine
Maulana Azad Medical College, New Delhi -110002

Approved

30/9/19

I/C MRD

I/C Peds

may do needful

I/C Medicine

allowed as per MC direction

I/C Ward III/IV

## 5. Pilot Testing

Pilot testing for the community survey was done in the field practice area of Department of Community Medicine, Maulana Azad Medical College, New Delhi and for the Hospitals, it was done in Guru Teg Bahadur Hospital, Dilshad Garden.

## 6. Supervision and Monitoring

Supportive supervision was done by the investigators to improve the efficiency of the staff.

FIs were asked to send daily live location to ensure their presence as well as safety.

Visits were done by project investigators in between also to keep a quality check on the work.

## 7. Tools used in the study:

- Predesigned questionnaire was used to fill information both in hospital and community settings.

The questionnaire has focused on the awareness and perception of the people towards air pollution and health effects due to air pollution.

- Perceived Stress Scale 4 (PSS-4)

It has been observed that increasing Air Pollution levels have an impact on psychological health also. So, perceived stress scale was used to assess the impact of increasing air pollution on the stress levels.

Source : Cohen, S., Kamarck, T., &Mermelstein, R. (1983). A global measure of perceived stress. Journal of Health and Social Behavior, 24, 385-396.

## 8. Feedback

A meeting was called for all the staff and investigators involved in the study on every Saturday. Feedback was given by the FIs and DEOs for the weekly progress and the challenges and barriers were discussed.

**9. <u>Ethical considerations</u>:** Ethical permission was taken from the Institutional Ethics Committee prior to the start of the study. Written and informed consent was taken from all study subjects.

**MAULANA AZAD MEDICAL COLLEGE**

**AND ASSOCIATED HOSPITAL**

**(Lok Nayak, Govind Ballabh Pant Hospital ,Guru Nanak Eye Centre, Chacha Nehru Bal Chikitsalaya & Janakpuri super speciality Hospital )**

**New Delhi –110 002**

(INSTITUTIONAL ETHICS COMMITTEE)

F.1/IEC/MAMC/(64/04/2018 /No/360

Dated: 22/11/18

To,

Dr. Nandini Sharma
(Supervisor of Ekta Arora)
Director Professor
Department of Community Medicine
Maulana Azad Medical College &
Associated Lok Nayak Hospitals
New Delhi 110002, India

Subject: Exemption for the Research Project "Impact of Air Pollution on Public Health – An Observation Study"

Dear Madam,

With reference to your letter no. 1157 dated 06/11/18 on the subject cited above, we have received your application for exemption from Ethics Committee approval of above research project in reference to the study you wish to conduct at MAMC

The Institutional Ethics Committee, MAMC has reviewed and discussed your application to conduct the Research Project entitled "Impact of Air pollution on Public Health, has been exempted

Yours,

(Dr. M.K.Daga)
Member Secretary (IEC)

22/11/2018
Date:

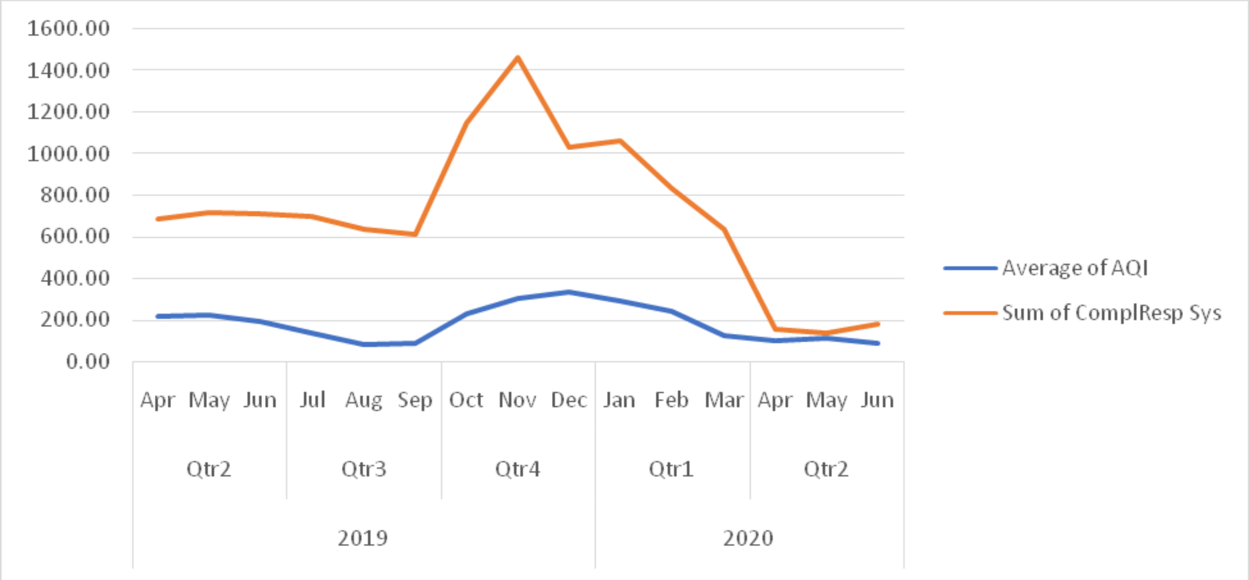
*__Highlights of Hospital Study__*


**DDU Hospital Front View**

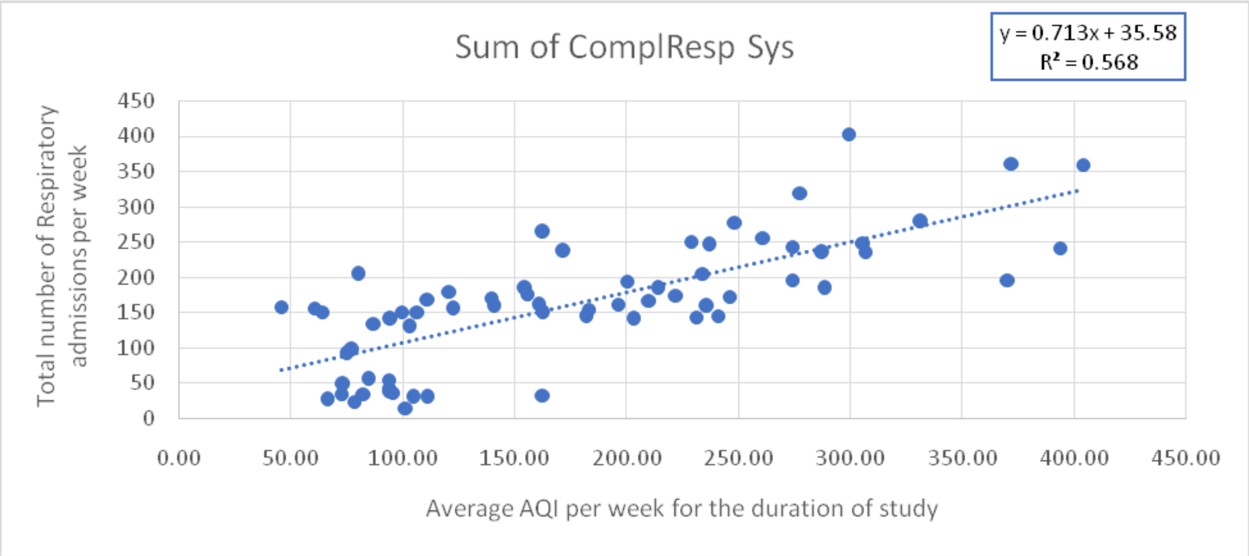

**DDU Hospital Main Entrance**

## Highlights of Hospital based study

### Line plot showing trend of Average AQI versus total respiratory admissions for that average AQI




### Scatter plot with regression line showing relation between AQI and respiratory admissions.



## Linear Regression model of Average AQI versus total respiratory admissions for that averageAQI

| SUMMARY OUTPUT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| *Regression Statistics* | | | | | | | | |
| Multiple R | 0.754190395 | | | | | | | |
| R Square | 0.568803153 | | | | | | | |
| Adjusted R Square | 0.562065702 | | | | | | | |
| Standard Error | 58.397991 | | | | | | | |
| Observations | 66 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | | | |
| Regression | 1 | 287913.6168 | 287913.6168 | 84.4240907 | 2.65726E-13 | | | |
| Residual | 64 | 218260.8225 | 3410.325352 | | | | | |
| Total | 65 | 506174.4394 | | | | | | |
| | | | | | | | | |
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 35.58805852 | 15.60020116 | 2.281256386 | 0.025870135 | 4.423074048 | 66.75304299 | 4.423074048 | 66.75304299 |
| Average of AQI | 0.713545525 | 0.077658409 | 9.188258306 | 2.65726E-13 | 0.558405017 | 0.868686032 | 0.558405017 | 0.868686032 |

y = b + mx (where y = total respiratory admissions, b = intercept, m = slope, x = Average AQI for the week)

Regression model: Total respiratory admissions for any week (as a function of AQI) = 35.58805852 +

(0.713545525 * Average AQI for the week)

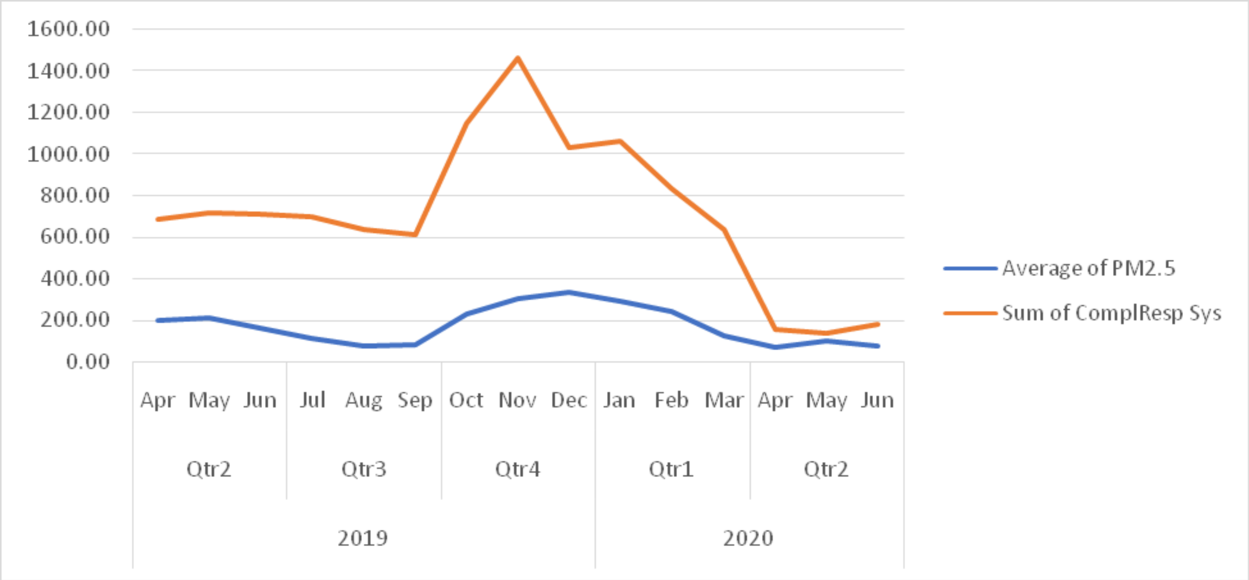
Interpretation of this model: This model is significant.

***Predictive Modelling: This suggests that an increase in 1 units of AQI will lead to an additional respiratory admission of 0.713 per week,keeping the other factors constant. For ease of understanding, 7 new cumulative respiratory admissions per week will be seen these hospitals with an increase of 10 units of AQI,assuming other factors to be constant.***

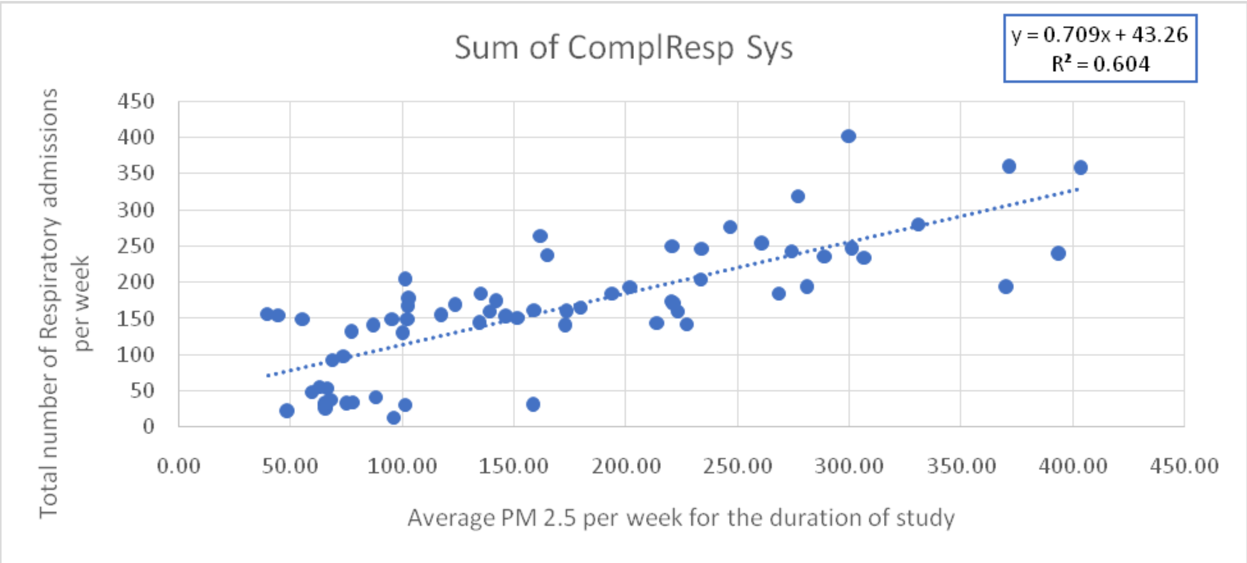
The increase in respiratory admissions (Bronchitis, Bronchial Asthma) are directly proportional to increase in AQI. This is in accordance with results of other studies which state that Air pollution can induce the acute exacerbation of respiratory diseases, thus increasing the respiratory morbidity and mortality*.

*Jiang XQ, Mei XD, Feng D. Air pollution and chronic airway diseases: what should people know and do?. *J Thorac Dis.* 2016;8(1): E31-E40. doi: 10.3978/j.issn.2072-1439.2015.11.50

**Line plot showing trend of Average PM2.5 versus total respiratory admissions for that averagePM2.5**




**Scatter plot with regression line showing relation between PM2.5 and respiratory admissions**



## Linear Regression of Average PM2.5 versus total respiratory admissions for that average PM2.5

| SUMMARY OUTPUT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| *Regression Statistics* | | | | | | | | |
| Multiple R | 0.777342679 | | | | | | | |
| R Square | 0.604261641 | | | | | | | |
| Adjusted R Square | 0.598078229 | | | | | | | |
| Standard Error | 55.94537541 | | | | | | | |
| Observations | 66 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | | | |
| Regression | 1 | 305861.7975 | 305861.7975 | 97.72301363 | 1.65726E-14 | | | |
| Residual | 64 | 200312.6419 | 3129.88503 | | | | | |
| Total | 65 | 506174.4394 | | | | | | |
| | | | | | | | | |
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 43.26686052 | 13.91548888 | 3.109259106 | 0.002798818 | 15.46747572 | 71.06624531 | 15.46747572 | 71.06624531 |
| Average of PM2.5 | 0.709142733 | 0.071735682 | 9.885495113 | 1.65726E-14 | 0.565834234 | 0.852451232 | 0.565834234 | 0.852451232 |

y = b + mx (where y = total respiratory admissions, b = intercept, m = slope, x = Average PM2.5for any week)

Regression model: Total respiratory admissions for any week (as a function of PM2.5) =

43.26686052+ (0.709142733* Average PM2.5 for that week)

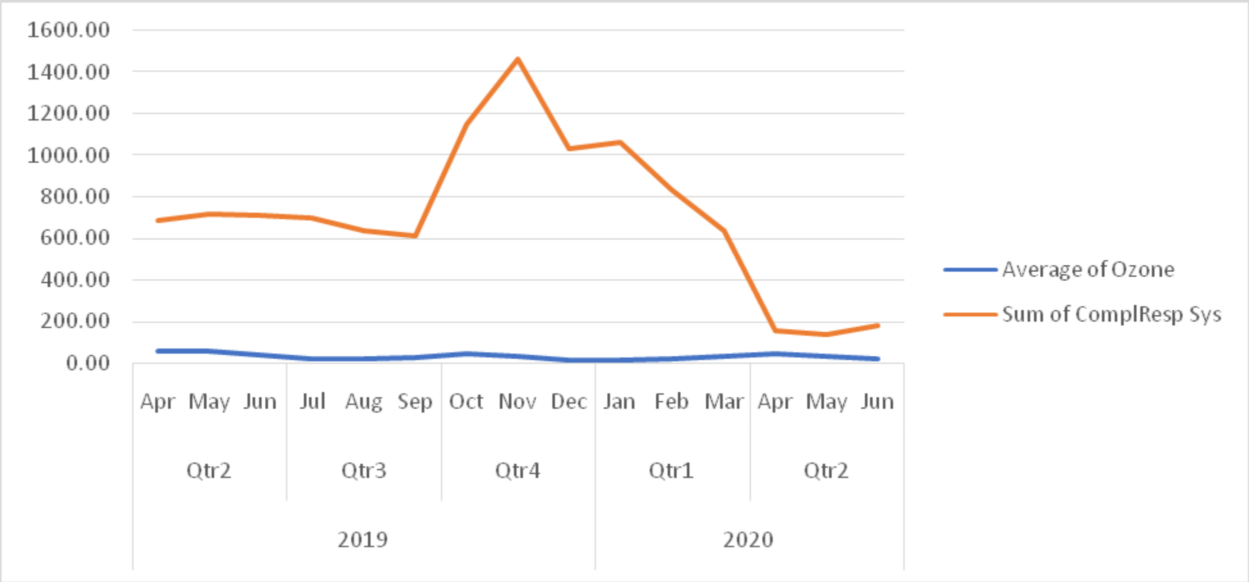
Interpretation of this model: This model is statistically significant (p-value is 1.65726E-14).

***Predictive Modelling: This suggests that an increase in 1 unit of PM2.5 will lead to an additional respiratory admission of 0.709 per week, keeping the other factors constant. For ease of understanding, 7.09 new cumulative respiratory admissions per week will be seen these hospitals with an increase of 10 units of PM 2.5, assuming other factors to be constant.***

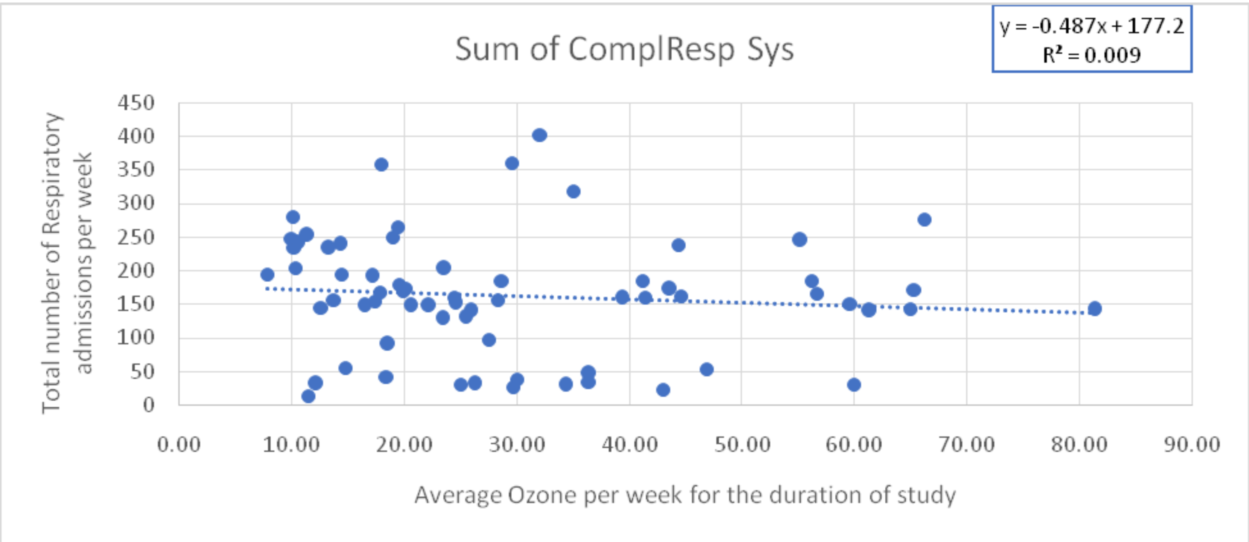
This increase in respiratory admissions (Bronchitis, Bronchial Asthma) are directly proportional to increase in PM 2.5. This is in accordance with other studies depicting that increased fine particulate matter ($PM_{2.5}$) concentrations can lead to elevated susceptibility to respiratory diseases like asthma, chronic obstructive pulmonary disease, and even lung cancer. *

*Li T, Hu R, Chen Z, et al. Fine particulate matter ($PM_{2.5}$): The culprit for chronic lung diseases in China. *Chronic Dis Transl Med*. 2018;4(3):176-186. Published 2018 Aug 28. doi: 10.1016/j.cdtm.2018.07.002

**Line plot showing trend of Average Ozone versus total respiratory admissions for that averageOzone**




**Scatter plot with regression line showing relation between ozone and respiratory admissions.**



**Linear Regression model of Average Ozone versus total respiratory admissions for that averageOzone**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SUMMARY OUTPUT | | | | | | | | |
| | | | | | | | | |
| *Regression Statistics* | | | | | | | | |
| Multiple R | 0.096236417 | | | | | | | |
| R Square | 0.009261448 | | | | | | | |
| Adjusted R Square | -0.006218842 | | | | | | | |
| Standard Error | 88.51964217 | | | | | | | |
| Observations | 66 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | | | |
| Regression | 1 | 4687.908217 | 4687.908217 | 0.598273547 | 0.442085158 | | | |
| Residual | 64 | 501486.5312 | 7835.72705 | | | | | |
| Total | 65 | 506174.4394 | | | | | | |
| | | | | | | | | |
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 177.2691813 | 21.64514187 | 8.189790685 | 1.49257E-11 | 134.0280395 | 220.510323 | 134.0280395 | 220.510323 |
| Average of Ozone | -0.487605335 | 0.630403401 | -0.773481446 | 0.442085158 | -1.746980904 | 0.771770235 | -1.746980904 | 0.771770235 |

y = b + mx (where y = total respiratory admissions, b = intercept, m = slope, x = Average Ozonefor any week)

Regression model: Total respiratory admissions for any week (as a function of Ozone) =

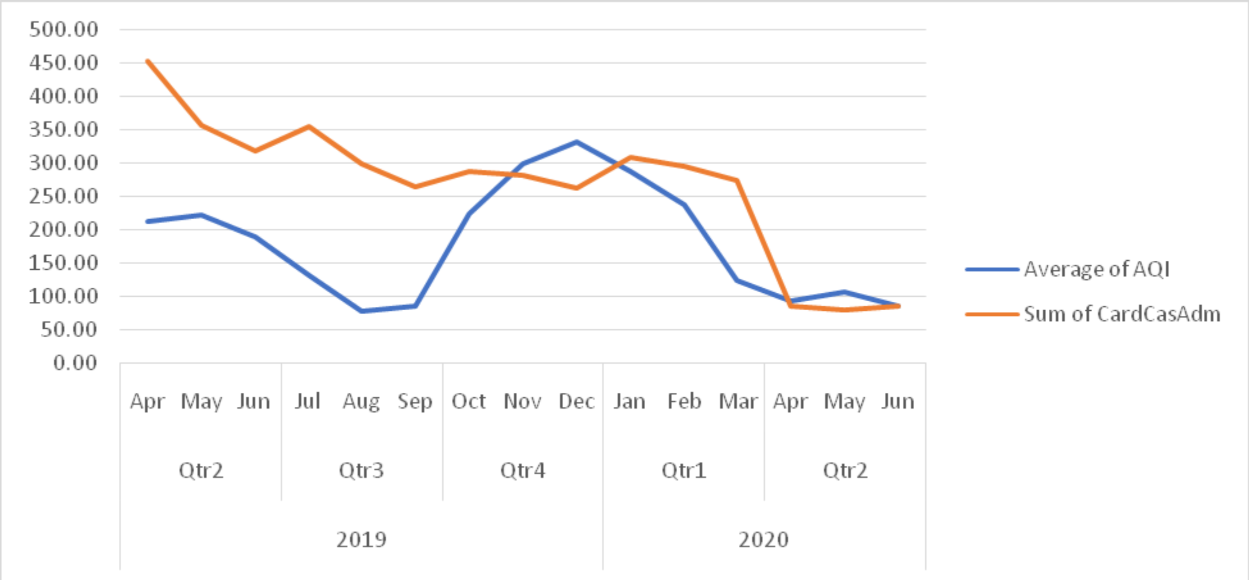
177.2691813 + (-0.487605335 * Average Ozone for that week)

***Predictive Modelling: This suggests that an increase in 1 units of Ozone will lead to an additional decrease of respiratory admission of 0.487 per week, keeping the other factors constant. For ease of understanding, 4.8 new cumulative respiratory admissions will be reported in these hospitals with decrease in 10 units of Ozone,assuming other factors to be constant.***

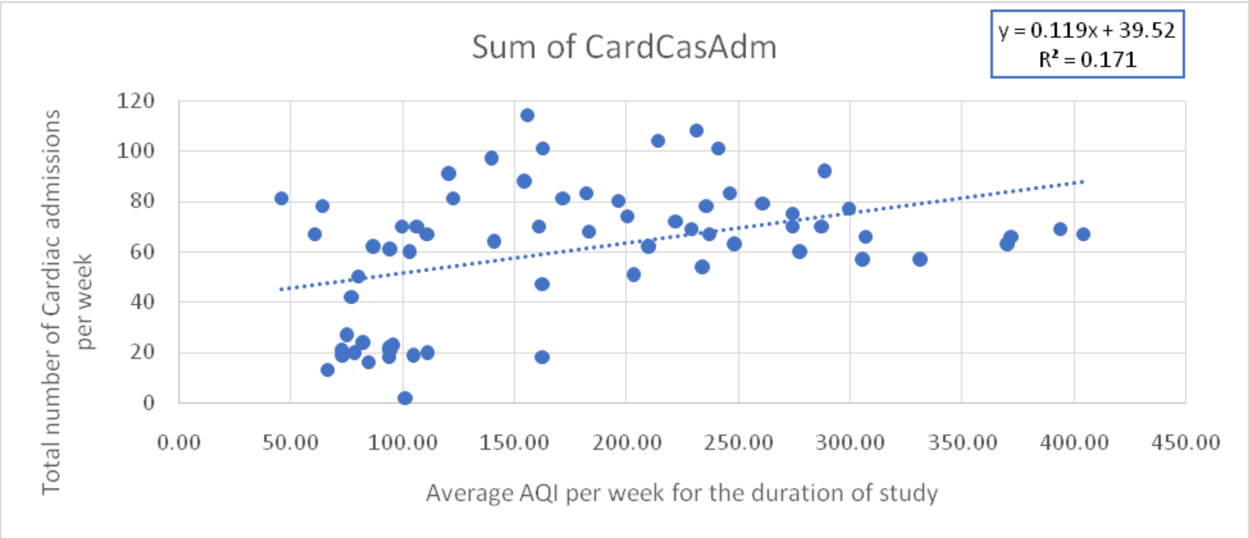
The study has been able to generate evidence that cardiopulmonary admissions in Hospitals increase significantly with rising Air pollution. However, no such relation could be established with Ozone, though no statistical significance could be established.


**<u>MRD Division, Guru Teg Bahadur Hospital, Dilshad Garden</u>**

**Line plot showing trend of Average AQI versus total cardiac admissions for that average AQI**




**Scatter plot with regression line showing relation between AQI and cardiac admissions.**



**Linear Regression model of Average AQI versus total cardiac admissions for that average AQI**

| SUMMARY OUTPUT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| *Regression Statistics* | | | | | | | | |
| Multiple R | 0.413664721 | | | | | | | |
| R Square | 0.171118501 | | | | | | | |
| Adjusted R Square | 0.158167228 | | | | | | | |
| Standard Error | 24.6368819 | | | | | | | |
| Observations | 66 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | | | |
| Regression | 1 | 8019.660433 | 8019.660433 | 13.21248467 | 0.000555525 | | | |
| Residual | 64 | 38846.46078 | 606.9759497 | | | | | |
| Total | 65 | 46866.12121 | | | | | | |
| | | | | | | | | |
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 39.52585893 | 6.581396158 | 6.005695142 | 9.90831E-08 | 26.37800866 | 52.6737092 | 26.37800866 | 52.6737092 |
| Average of AQI | 0.119088157 | 0.032762447 | 3.634898166 | 0.000555525 | 0.053637646 | 0.184538668 | 0.053637646 | 0.184538668 |

y = b + mx (where y = total cardiac admissions, b = intercept, m = slope, x = Average AQI for any week)

Regression model: Total cardiac admissions for any week (as a function of AQI) = 39.52585893 +(0.119088157 * Average AQI for that week)

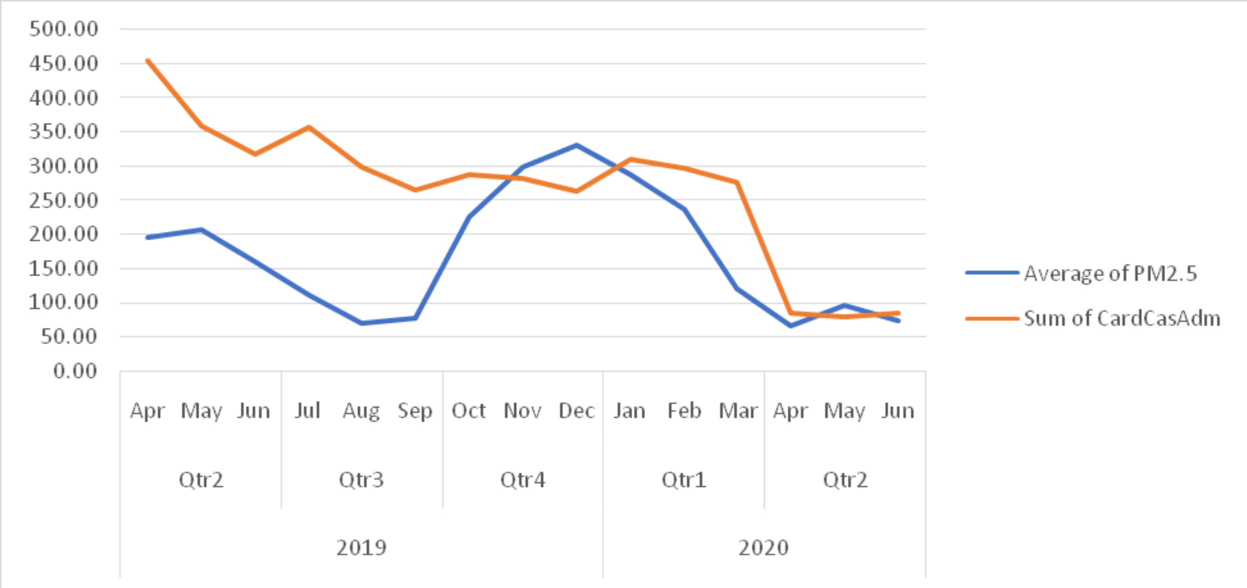
Interpretation of this model: The model is significant (p-value is 0.000555525).

***Predictive Modelling: This suggests that an increase in 1 unit of AQI will lead to an additional Cardiac admission of 0.1190 per week, keeping the other factors constant. For ease of understanding, assuming other factors to be constant, an increase of 10 units of AQI will increase 1.19 new cumulative cardiac admissions per week in these hospitals.***

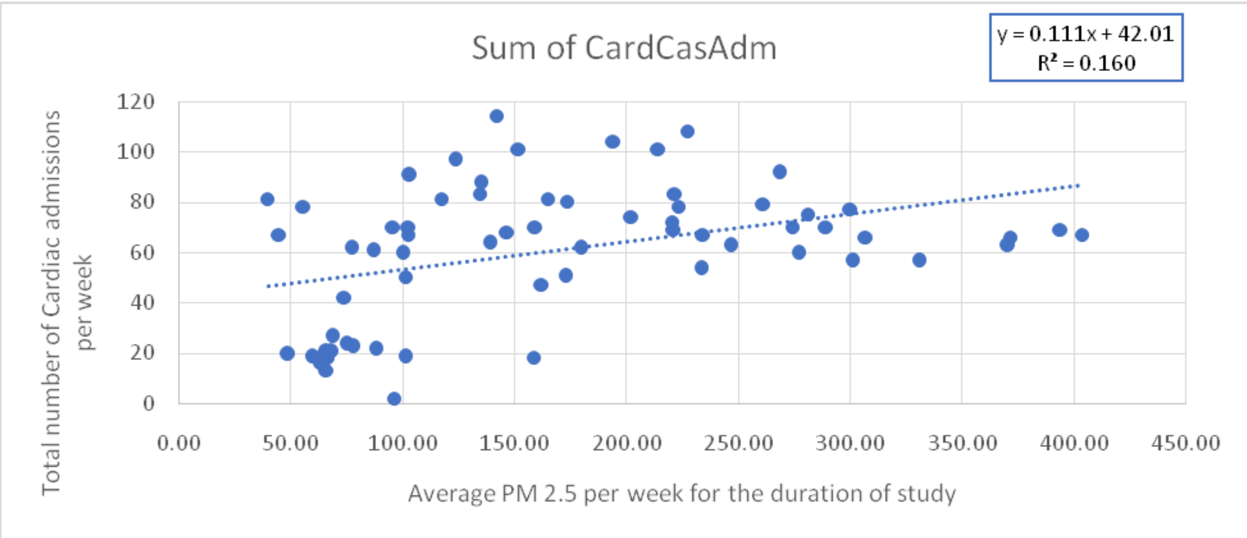
The increase in cardiac admissions is directly proportional to increase in AQI. The same has been explained in other studies which suggest that exposure to relatively higher levels of average annual $PM_{2.5}$ & AQI may increase the likelihood of cardiac diseases like Ischemic Heart Disease. *

*Balluz L, Wen XJ, Town M, Shire JD, Qualter J, Mokdad A. Ischemic heart disease and ambient air pollution of particulate matter 2.5 in 51 counties in the U.S. *Public Health Rep*. 2007;122(5):626-633. doi:10.1177/003335490712200510

**Line plot showing trend of Average PM2.5 versus total cardiac admissions for that averagePM2.5**




**Scatter plot with regression line showing relation between PM2.5 and cardiac admissions**



**Linear Regression of Average PM2.5 versus total cardiac admissions for that average PM2.5**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SUMMARY OUTPUT | | | | | | | | |
| | | | | | | | | |
| *Regression Statistics* | | | | | | | | |
| Multiple R | 0.400664002 | | | | | | | |
| R Square | 0.160531642 | | | | | | | |
| Adjusted R Square | 0.147414949 | | | | | | | |
| Standard Error | 24.79371953 | | | | | | | |
| Observations | 66 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | | | |
| Regression | 1 | 7523.495398 | 7523.495398 | 12.23872824 | 0.000857126 | | | |
| Residual | 64 | 39342.62581 | 614.7285283 | | | | | |
| Total | 65 | 46866.12121 | | | | | | |
| | | | | | | | | |
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 42.00993826 | 6.167028569 | 6.812022643 | 3.97193E-09 | 29.6898824 | 54.32999411 | 29.6898824 | 54.32999411 |
| Average of PM2.5 | 0.111219482 | 0.031791625 | 3.498389378 | 0.000857126 | 0.047708411 | 0.174730553 | 0.047708411 | 0.174730553 |

y = b + mx (where y = total cardiac admissions, b = intercept, m = slope, x = Average PM2.5 for any week)

Regression model: Total cardiac admissions for any week (as a function of PM2.5) = 42.00993826+ (0.111219482 * Average PM2.5 for that week)

Interpretation of this model: The model is Significant (p-value is 0.000857126).

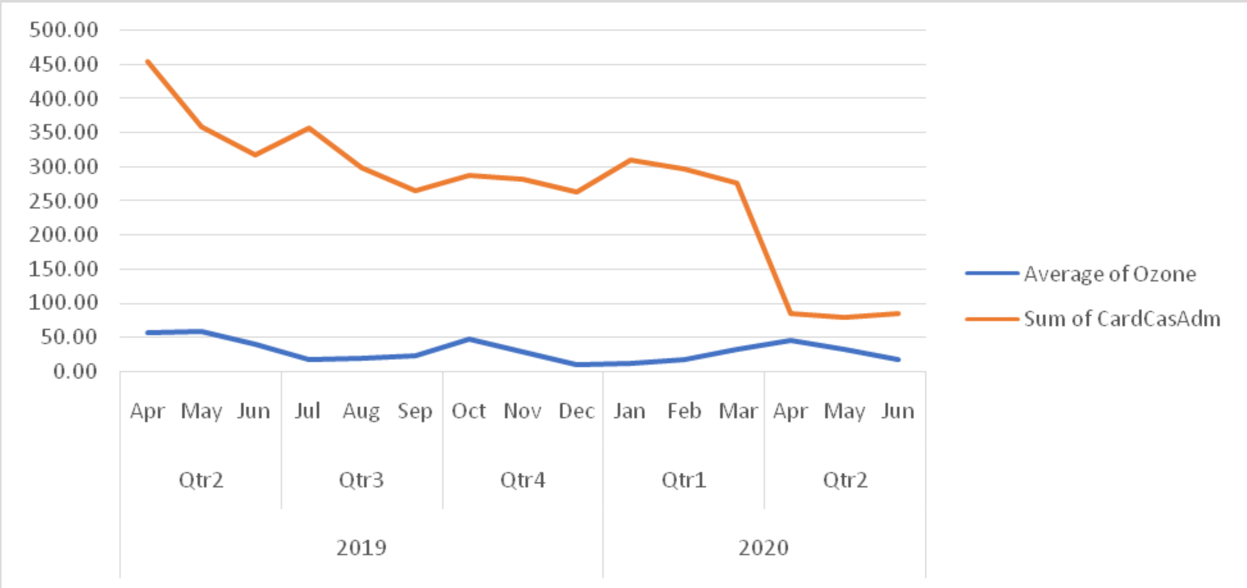
***Predictive Modelling: This suggests that an increase in 1 units of PM2.5 will lead to an additional Cardiac admissions of 0.111per week keeping other factors constant. Thus, assuming other factors to be constant, an increase of 10 units of PM2.5 will increase 1.1 new cumulative cardiac admissions per week in these hospitals.***

The increase in cardiac admissions is directly proportional to increase in PM2.5.

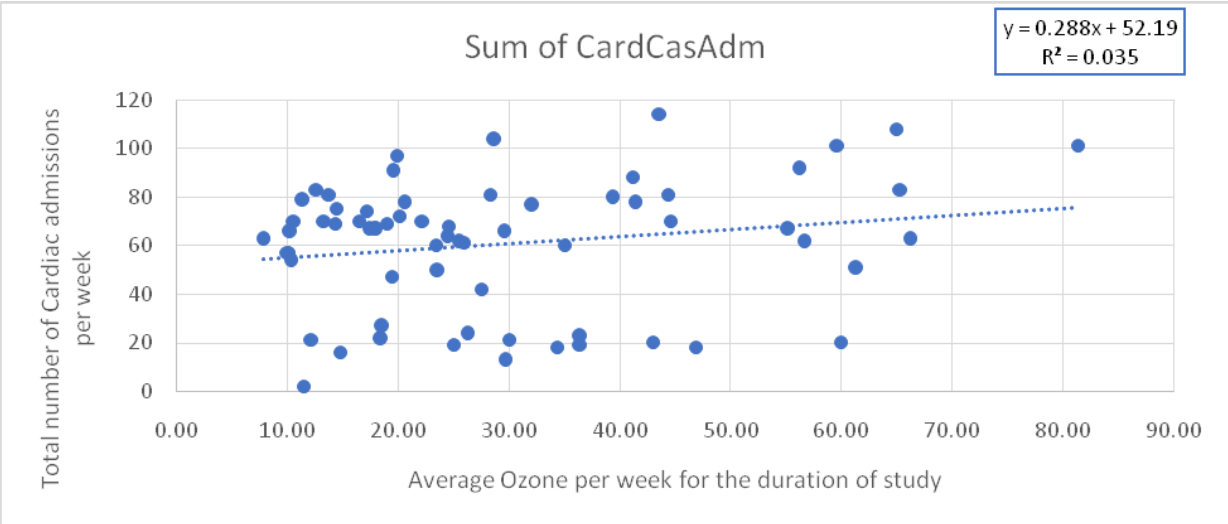
The same has been explained in other studies which suggest that exposure to relatively higher levels of average annual $PM_{2.5}$ & AQI may increase the likelihood of cardiac diseases like Ischemic Heart Disease. *

*Balluz L, Wen XJ, Town M, Shire JD, Qualter J, Mokdad A. Ischemic heart disease and ambient air pollution of particulate matter 2.5 in 51 counties in the U.S. *Public Health Rep*. 2007;122(5):626-633. doi:10.1177/003335490712200510

**Line plot showing trend of Average Ozone versus total cardiac admissions for that averageOzone**




**Scatter plot with regression line showing relation between ozone and cardiac admissions.**



## Linear Regression model of Average Ozone versus total cardiac admissions for that averageOzone

| SUMMARY OUTPUT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| *Regression Statistics* | | | | | | | | |
| Multiple R | 0.187270615 | | | | | | | |
| R Square | 0.035070283 | | | | | | | |
| Adjusted R Square | 0.019993256 | | | | | | | |
| Standard Error | 26.58198199 | | | | | | | |
| Observations | 66 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | | | |
| Regression | 1 | 1643.608147 | 1643.608147 | 2.326074212 | 0.132149178 | | | |
| Residual | 64 | 45222.51306 | 706.6017666 | | | | | |
| Total | 65 | 46866.12121 | | | | | | |
| | | | | | | | | |
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 52.19188117 | 6.499922021 | 8.02961651 | 2.85857E-11 | 39.2067942 | 65.17696815 | 39.2067942 | 65.17696815 |
| Average of Ozone | 0.288720779 | 0.189306819 | 1.525147275 | 0.132149178 | -0.089463067 | 0.666904625 | -0.089463067 | 0.666904625 |

y = b + mx (where y = total cardiac admissions, b = intercept, m = slope, x = Average Ozone for any week)

Regression model: Total cardiac admissions for any week (as a function of Ozone) = 52.1918817

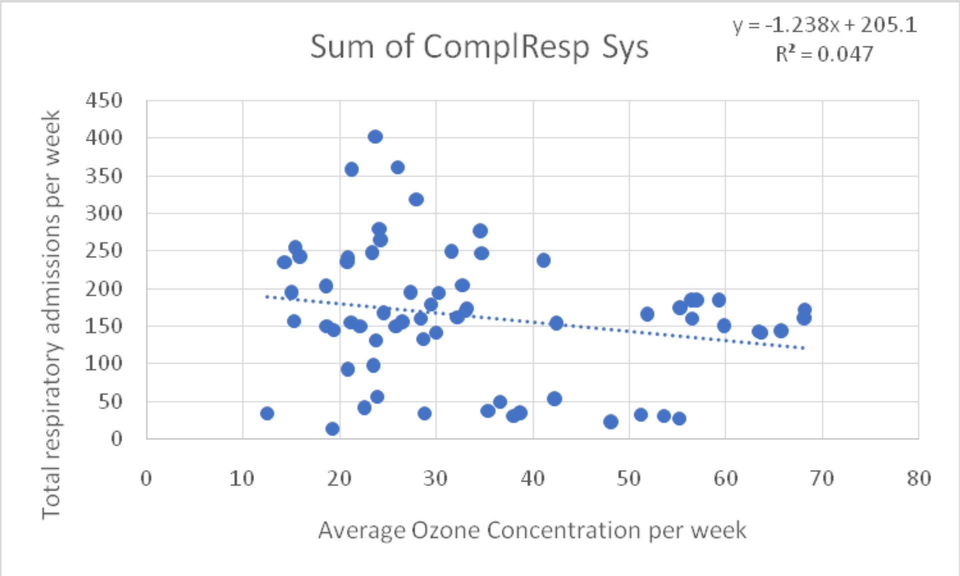
+ (0.288720779 * Average Ozone for that week)

Interpretation of this model: Non-significant.

## ***Additional Findings-***

1. **Impact of Ozone on Respiratory and Cardiac admissions was replotted with Ozone data provided by Delhi Pollution Control Committee.**

**Scatter plot with regression line showing relation between ozone and Respiratory admissions.**



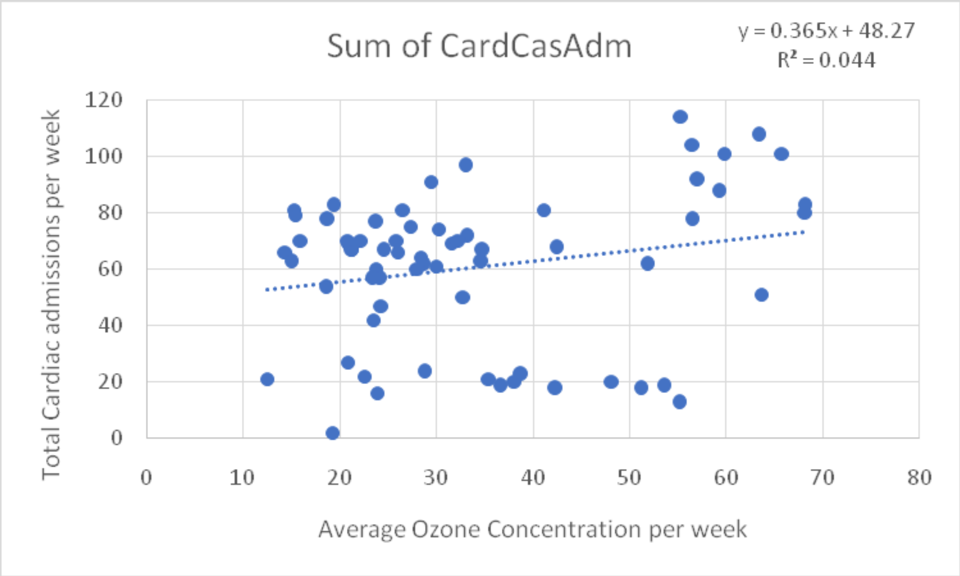

y = b + mx (where y = total respiratory admissions, b = intercept, m = slope, x = Average Ozone for any week)

Regression model: Total respiratory admissions for any week (as a function of Ozone) =

205.16 + (-1.2389 * Average Ozone for that week)

***Predictive Modelling: This suggests that an increase in 1 units of Ozone will lead to an additional decrease of respiratory admission of 1.2 per week, assuming the other factors constant.***

**Scatter plot with regression line showing relation between ozone and Cardiac admissions.**




y = b + mx (where y = total cardiac admissions, b = intercept, m = slope, x = Average Ozone for any week)

Regression model: Total cardiac admissions for any week (as a function of Ozone) = 48.271

+ (0.3653 * Average Ozone for that week)

Interpretation of this model: Non-significant.

## 2. Impact of PM 2.5 on Respiratory admissions for Quarter 3 (July-Sep,2019) & Quarter 4 (Oct-Dec,2019)

| Q3 2019 vs Q4 2019 (PM2.5) | | |
|---|---|---|
| | Q3 2019 | Q4 2019 |
| Average | 87.48 | 280.10 |
| SD | 41.80 | 108.91 |
| SEM | 4.36 | 11.35 |
| N | 92 | 92 |
| *p-value* | The two-tailed P value is less than 0.0001. By conventional criteria, this difference is considered to be extremely statistically significant. | |

| Q3 2019 vs Q4 2019 (Respiratory Admissions) | | |
|---|---|---|
| | Q3 2019 | Q4 2019 |
| Average | 21.26 | 39.73 |
| SD | 6.53 | 11.20 |
| SEM | 0.68 | 1.17 |
| N | 92 | 92 |
| *p-value* | The two-tailed P value is less than 0.0001. By conventional criteria, this difference is considered to be extremely statistically significant. | |

PM2.5 and Respiratory admissions were found to be higher in Oct-Dec,2019 period as compared to July-Sep,2019 quarter. This association was found to be highly significant and can be attributed to higher pollution levels in this particular period.

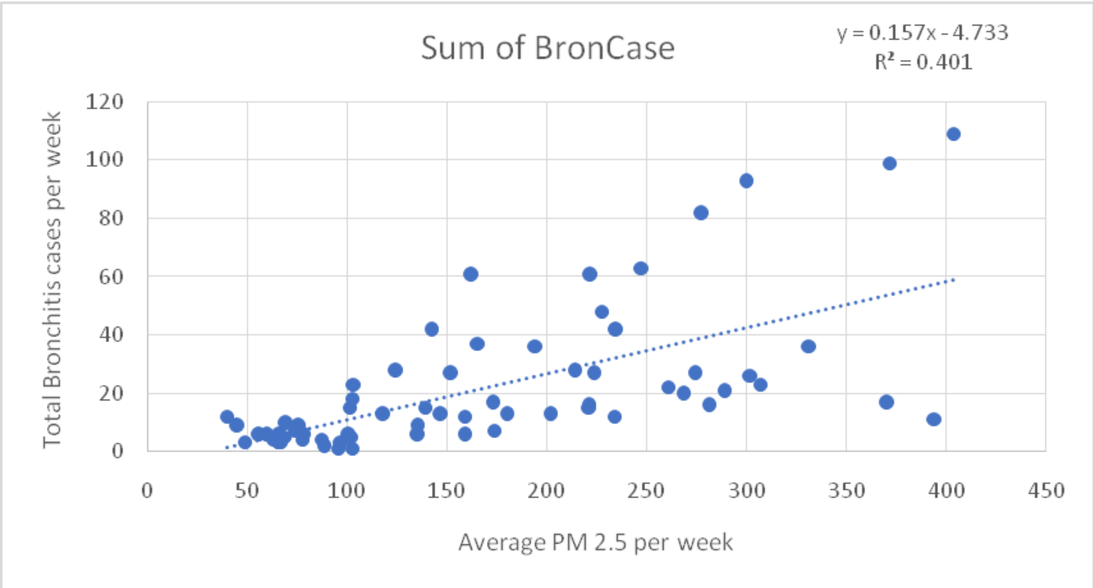
3. **<u>Impact of PM 2.5 on Respiratory admissions for Quarter 4 (Oct-Dec,2019) & Quarter 1-2020 (Jan-March,2020)</u>**

| Q4 2019 vs Q1 2020 (PM2.5) | | |
|---|---|---|
| | Q4 2019 | Q1 2020 |
| Average | 280.10 | 211.03 |
| SD | 108.91 | 95.58 |
| SEM | 11.35 | 10.02 |
| N | 92 | 91 |
| *p-value* | The two-tailed P value is less than 0.0001. By conventional criteria, this difference is considered to be extremely statistically significant. | |

| Q4 2019 vs Q1 2020 (Respiratory Admissions) | | |
|---|---|---|
| | Q4 2019 | Q1 2020 |
| Average | 39.73 | 27.85 |
| SD | 11.20 | 9.00 |
| SEM | 1.17 | 0.94 |
| N | 92 | 91 |
| *p-value* | The two-tailed P value is less than 0.0001. By conventional criteria, this difference is considered to be extremely statistically significant. | |

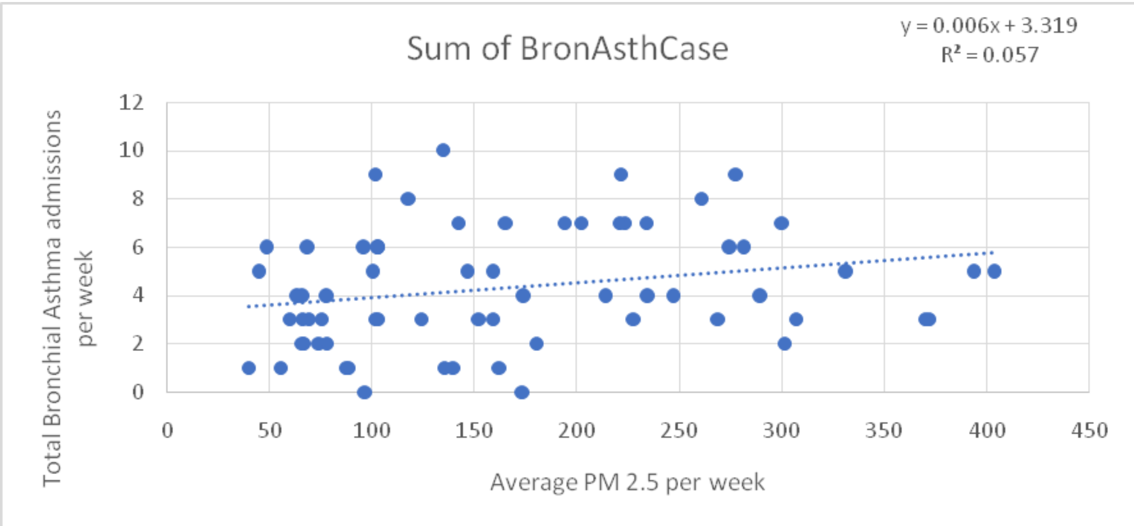
PM2.5 and Respiratory admissions were found to be higher in Oct-Dec,2019 period as compared to Jan-March,2020 quarter. This association was found to be highly significant and can be attributed to higher pollution levels in this particular period.

4. **Scatter plot with regression line showing relation between PM2.5 and differential Respiratory admissions - Bronchitis**



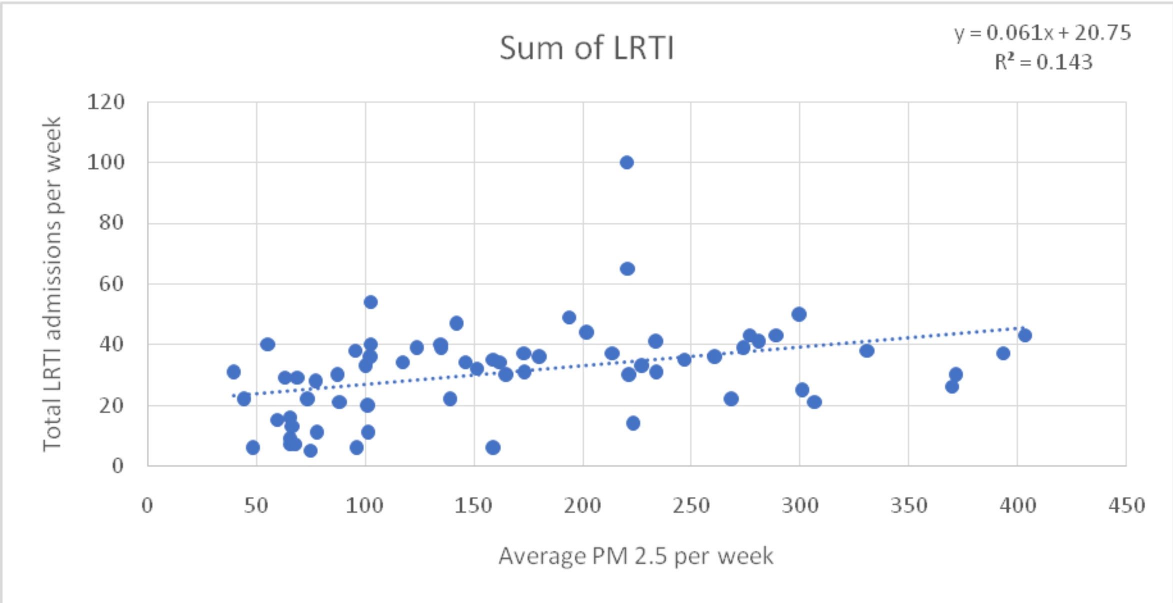

The impact of PM2.5 on individual respiratory conditions is also observed. It is found that admissions due to Bronchitisare directly proportional to increase in PM2.5.

5. **Scatter plot with regression line showing relation between PM2.5 and differential Respiratory admissions – Bronchial Asthma**



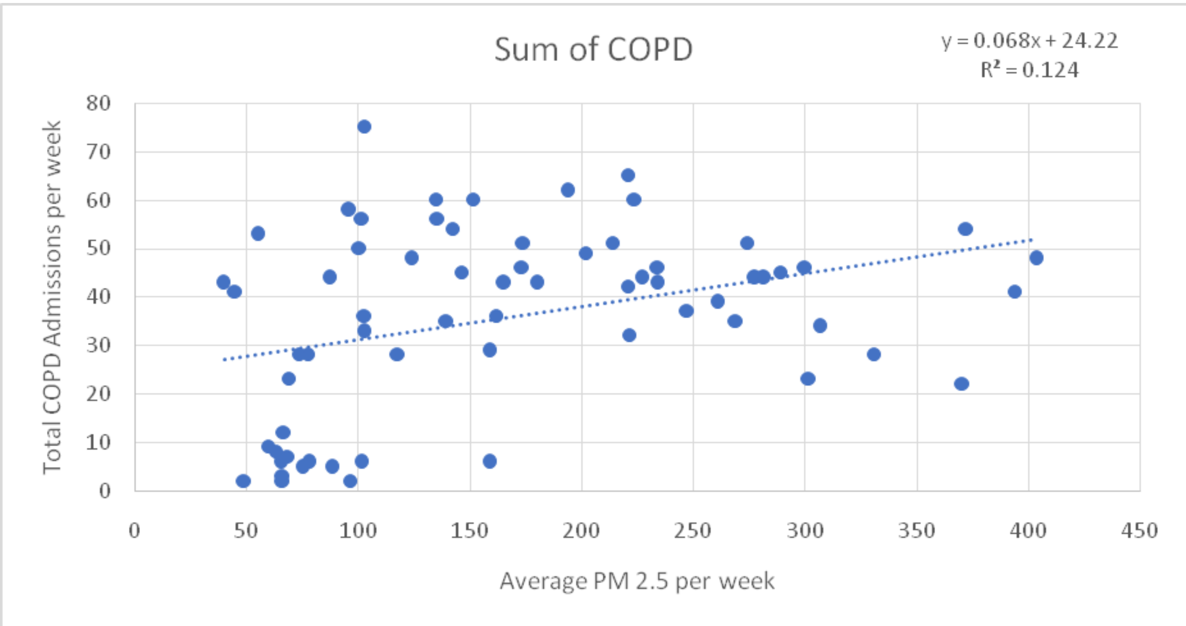

The impact of PM2.5 on individual respiratory conditions is also observed. It is found that admissions due to Bronchial Asthma are directly proportional to increase in PM2.5.

6. **Scatter plot with regression line showing relation between PM2.5 and differential Respiratory admissions –Lower Respiratory Tract Infections (LRTI)**



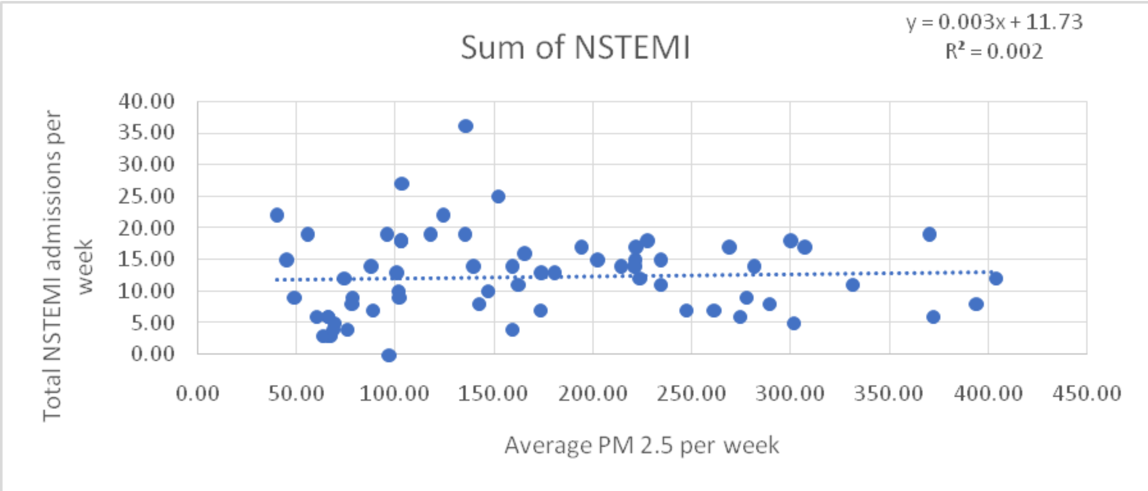

The impact of PM2.5 on individual respiratory conditions is also observed. It is found that admissions due to LRTI are directly proportional to increase in PM2.5.

7. **Scatter plot with regression line showing relation between PM2.5 and differential Respiratory admissions - COPD**



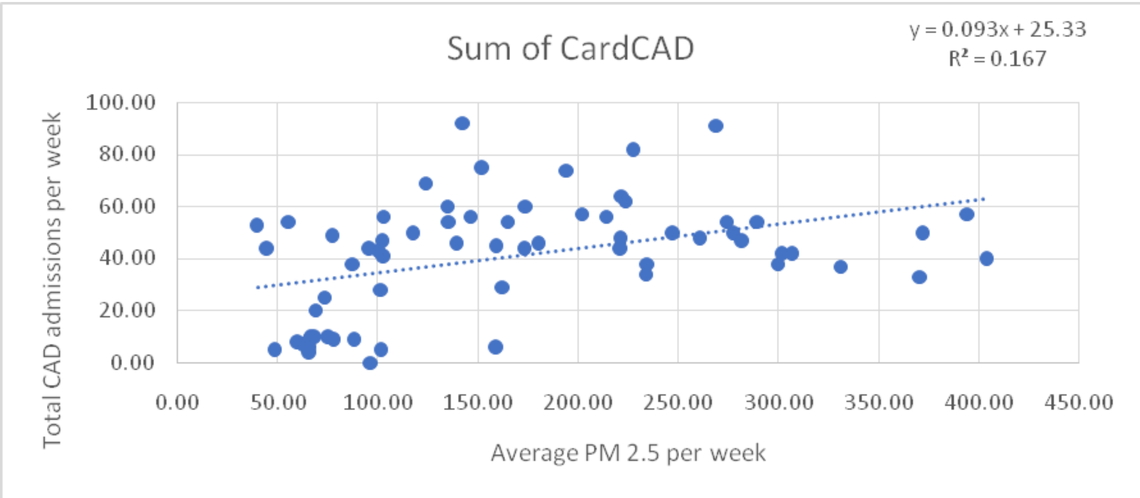

The impact of PM2.5 on individual respiratory conditions is also observed. It is found that admissions due to COPD are directly proportional to increase in PM2.5.

8. **Scatter plot with regression line showing relation between PM2.5 and differential Cardiac admissions - NSTEMI**



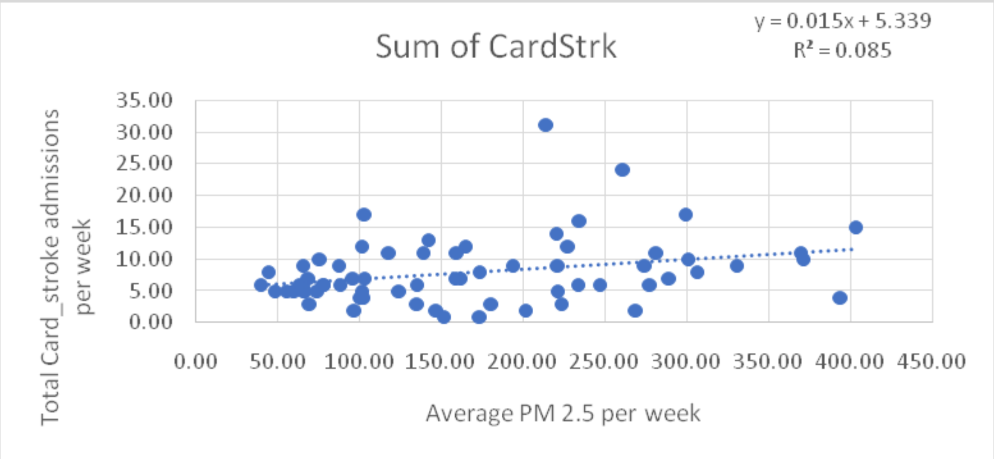

The impact of PM2.5 on individual cardiac conditions is also observed. It is found that admissions due to NSTEMI are directly proportional to increase in PM2.5.

9. **Scatter plot with regression line showing relation between PM2.5 and differential Cardiac admissions - Coronary Artery Disease(CAD)**




The impact of PM2.5 on individual cardiac conditions is also observed. It is found that admissions due to Coronary Artery Disease are directly proportional to increase in PM2.5.

10. **Scatter plot with regression line showing relation between PM2.5 and differential Cardiac admissions - Stroke**

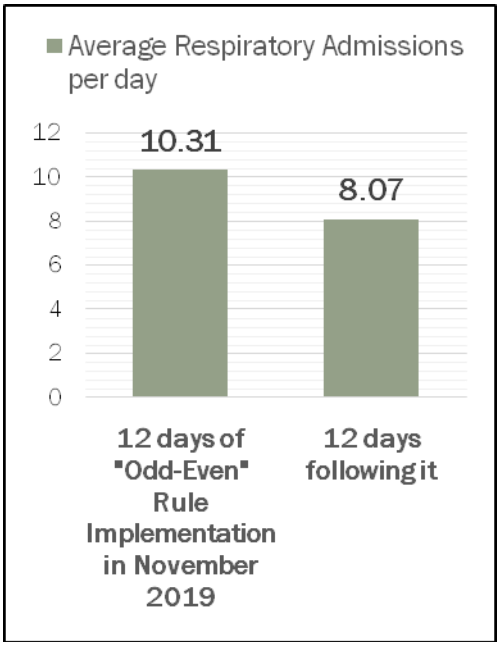



The impact of PM2.5 on individual cardiac conditions is also observed. It is found that admissions due to Stroke are directly proportional to increase in PM2.5.

11. **Analysis showing trends of PM2.5 versus total respiratory admissions during "12 days of Odd-Even Rule" Implementation and 12 days after that (Data provided by DPCC)**

| | Group 1(12 days of Odd-Even) | Group 2 (12 days following it) |
|---|---|---|
| Average | 266 | 143 |
| Standard Deviation | 118.7190489 | 48.72928704 |
| SEM | 34.26 | 14.06 |
| *p-value* | 0.003111125 | |

*The two-tailed P value is 0.0365* ***(Statistically significant)***




*The two-tailed P value is 0.4416* ***(Statistically non-significant)***

The impact of Odd/Even rule implementation was also observed on PM2.5 and respiratory admissions. Though a significant lowering of PM2.5 was observed, yet decrease in respiratory admissions wasn't significant. This needs to be studied for longer period for assessing the impact on the number of hospital admissions.

**Trends of Average AQI versus total respiratory admissions for that average AQI during Pre-Lockdown and Lockdown due to COVID.**

***Pre-lockdown vs lockdown:*** There is a statistically significant decrease in the respiratory admissions in all hospitals cumulatively during lockdown compared to pre-lockdown. The possible reasons are:

1. Statistically significant decrease in AQI levels during lockdown due to decrease in traffic and industries.
2. Other possibility could be the change in behavior/attitude of the public towards visiting the hospitals, as the fear of getting infected with COVID-19 discourages them to visit the hospitals/getting admitted in the respiratory wards.

## ***Highlights of Community Study***

**Baseline Characteristics of the sample:**

In this study, we have recruited a total of 1879 participants of which 1272 (67.7%) were males and 607 (32.3%) were females. Mean age of males were 38.13 ± 13.76 years while for females, it was bit higher, 40.25 ± 25.04 years. Overall mean age of all respondents was 38.82 ± 18.21 years. About half of study respondents (52.3%) belonged to age group of 20-39 years followed by 40-59 years age group who constituted 35.7% of total sample. However, respondents belonging to 10-19 years of age group constituted only 4.4% of study sample

More than one-fourth (29.75%) of the participants were graduated whereas approx. 14% respondents were illiterate. Nearly half of the respondents (54.71%) resided in urban areas whereas remaining participants were from rural areas (11.02%), slums (13.09%), JJ clusters (17.4%) and resettlement colonies (3.73%).

**Table 1. Baseline Characteristics of the sample:**

| Baseline Parameters | Values |
|---|---|
| Total recruited sample | 1879 |
| Gender Ratio | 1272 Males: 607 Females |
| Mean Age | 38.82 ± 18.21 years |
| Males | 38.13 ± 13.76 years |
| Females | 40.25 ± 25.04 years |
| Age Distribution | |
| <20 years | 82 (4.36%) |
| 20-39 years | 983 (52.32%) |
| 39-59 years | 671 (35.71%) |
| >60 years | 143 (7.61%) |
| Education Status | |
| Illiterate | 258 (13.73%) |
| Primary | 210 (11.18%) |
| Matric | 482 (25.65%) |
| Graduation | 559 (29.75%) |
| Post-Graduation | 331 (17.62%) |
| Doctoral | 39 (2.08%) |
| Type of Area | |
| Slums | 246 (13.09%) |
| Resettlement | 70 (3.73%) |
| JJ_Cluster | 327 (17.4%) |
| Urban | 1028 (54.71%) |
| Commercial | 1 (0.05%) |
| Rural | 207 (11.02%) |

**Fig:1 Age Distribution of the Respondents**

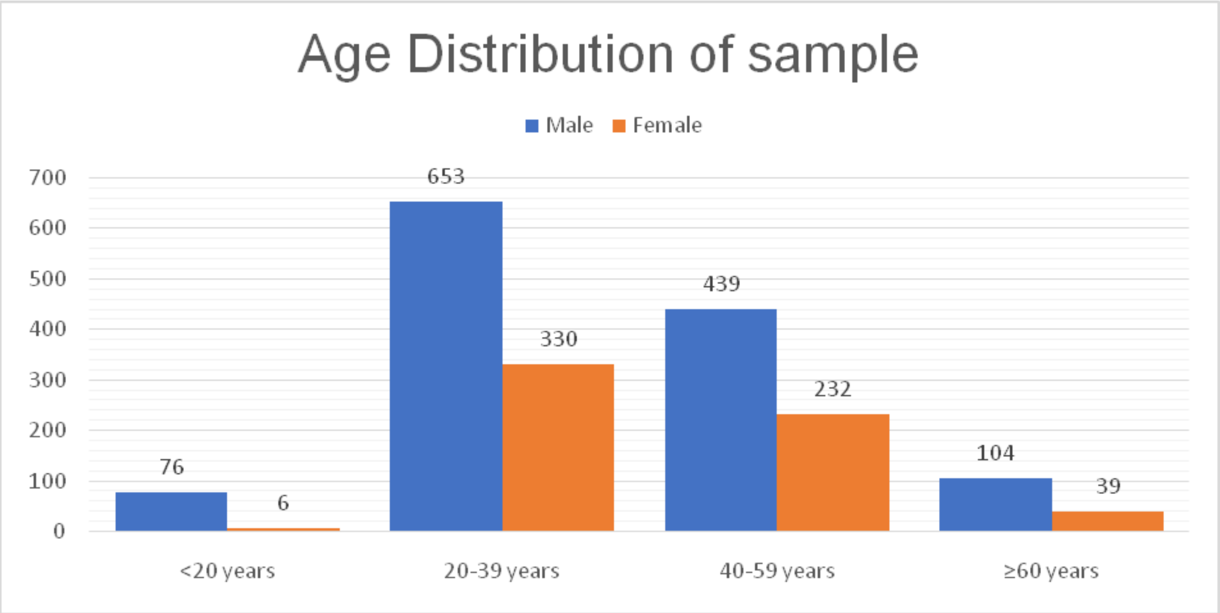



**Fig:2 Gender Distribution of the Respondents**

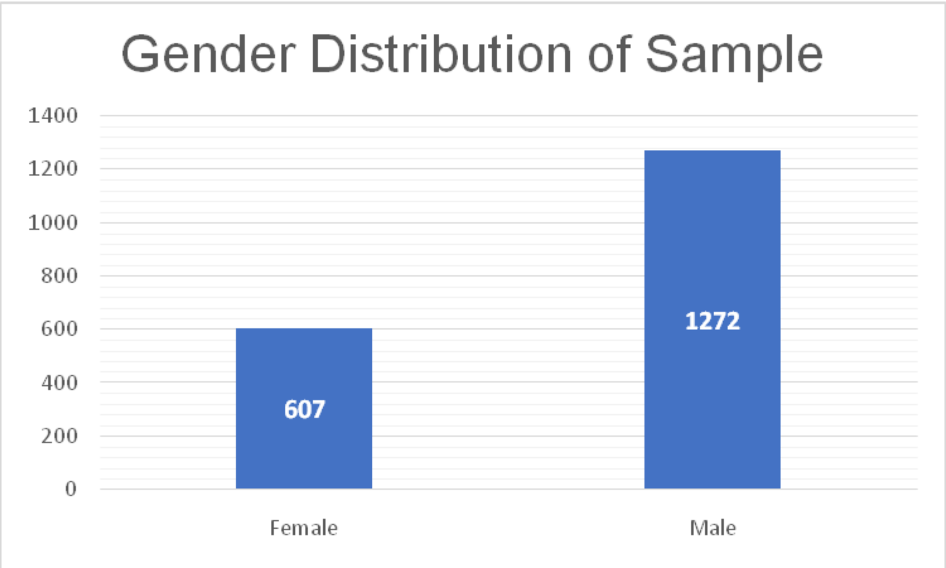
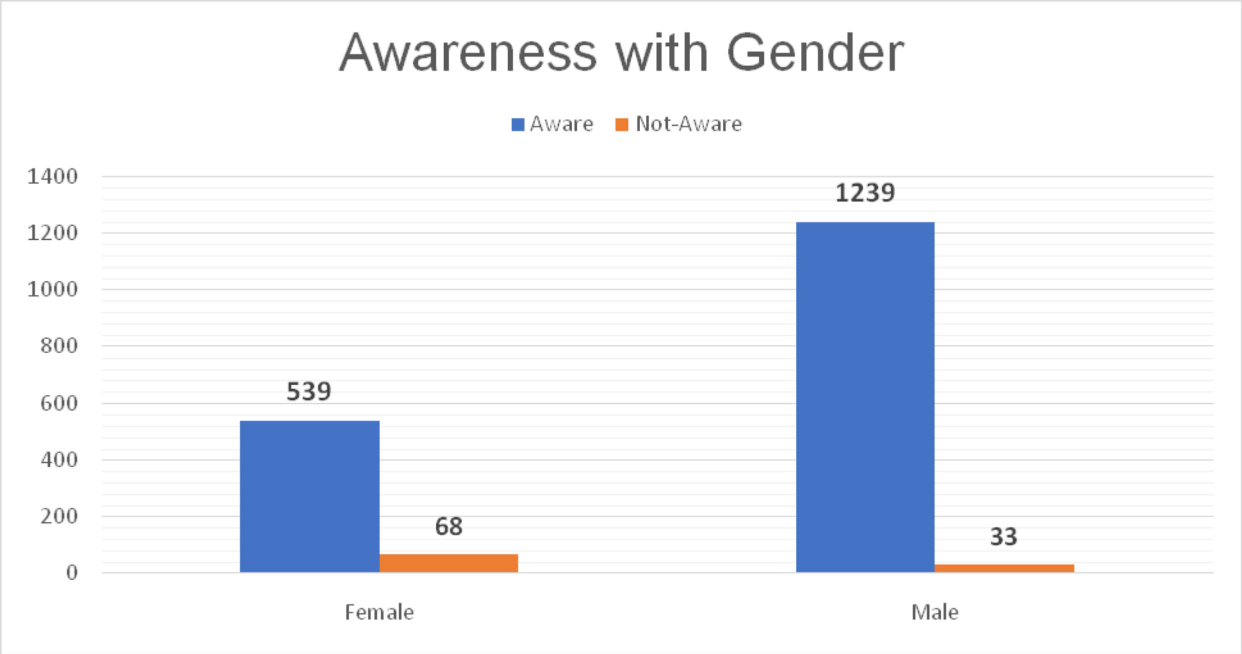


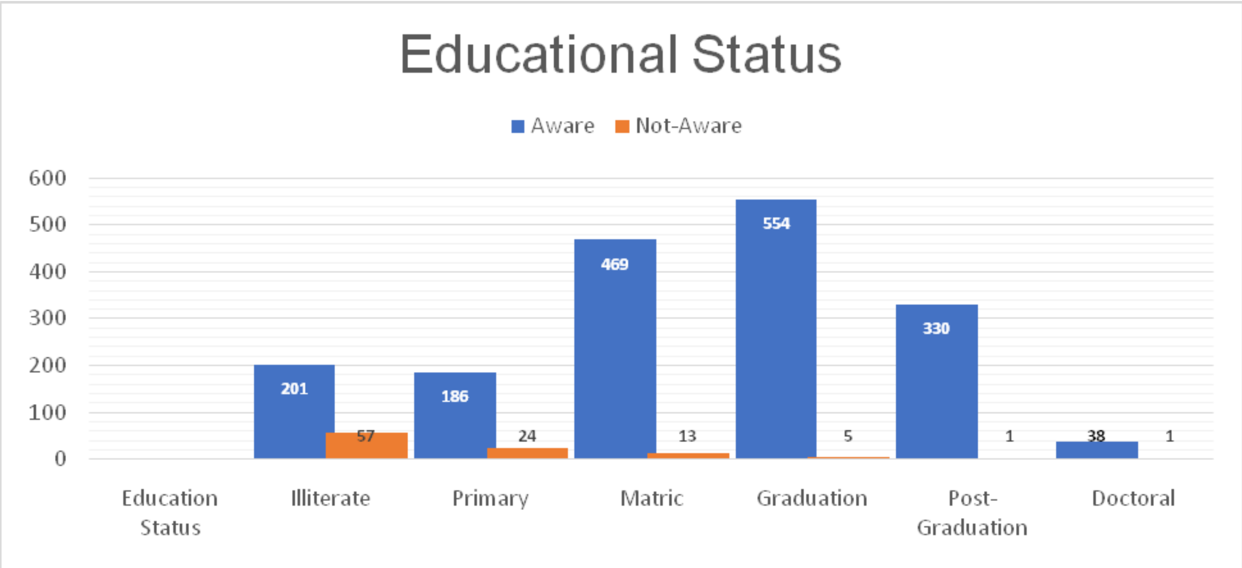
**Fig: 3 Distribution of respondents according to Awareness of Air Pollution based on Gender**




Out of total participants who took part in the study, majority of participants (95%) were aware about air pollution. Only 5.38% were unaware about air pollution.

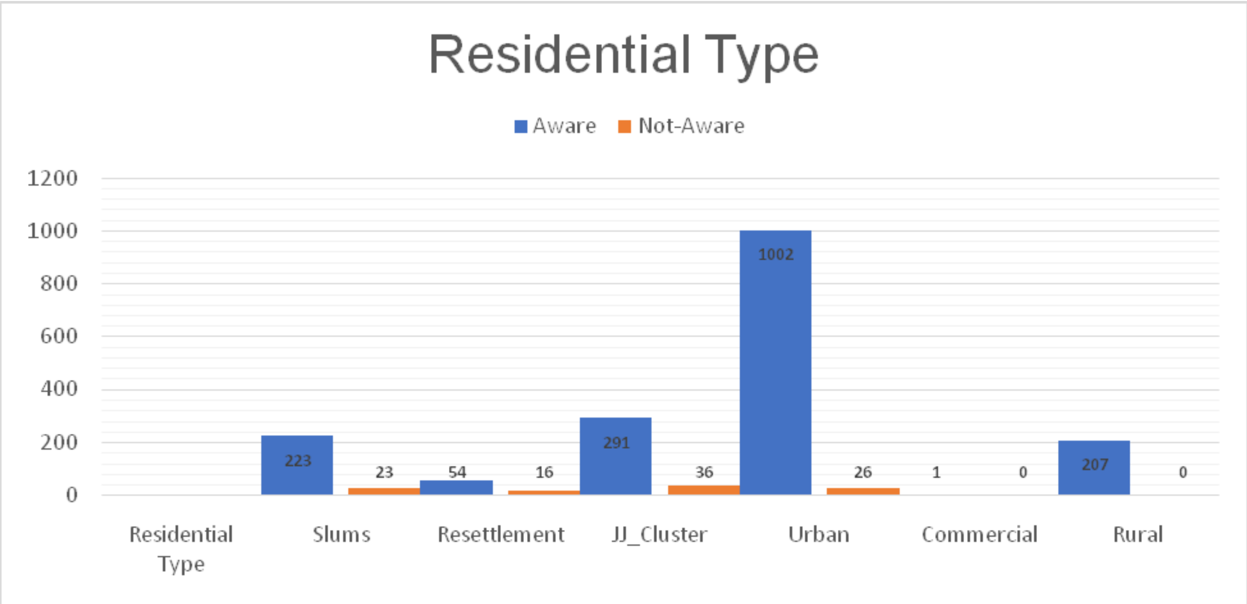
Regarding awareness of air pollution based on gender, it was observed that majority of males (70%) were aware about air pollution whereas 30% females were aware which came out to be statistically significantly. (**p value, 0.0001**)

**Fig: 4 Distribution of Respondents according to Awareness of Air Pollution based on Education Status**




As per the educational status of the participants, it was observed that highest awareness levels of air-pollution were found in respondents who were graduate. It also shows that as educational status gets better, awareness levels of air pollution also gets better. There is huge gap between awareness levels of illiterate and those who were metric and above. Thus, it suggests that education plays a key role in improving awareness level of the community.

**<u>Fig: 5 Distribution of Respondents according to awareness about Air Pollution based on type of Residential Area</u>**




One of the characteristics finding of study was that respondents belonging to rural area were fully aware about air-pollution (100%). However, this could be result of smaller proportion of respondents from rural area as compared to those from urban areas. Lowest awareness levels were seen in respondents those belonged to resettlement area (77%).

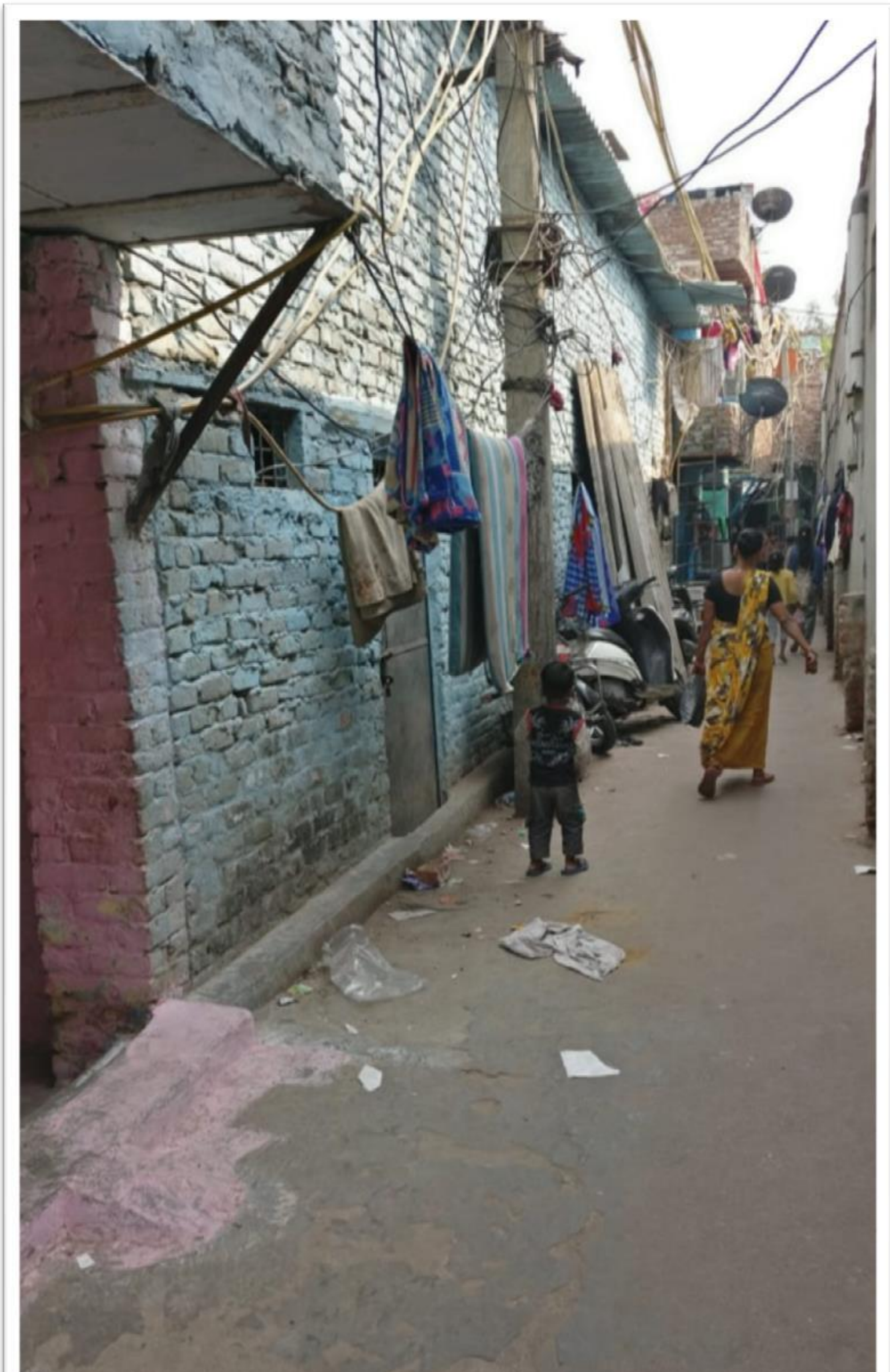
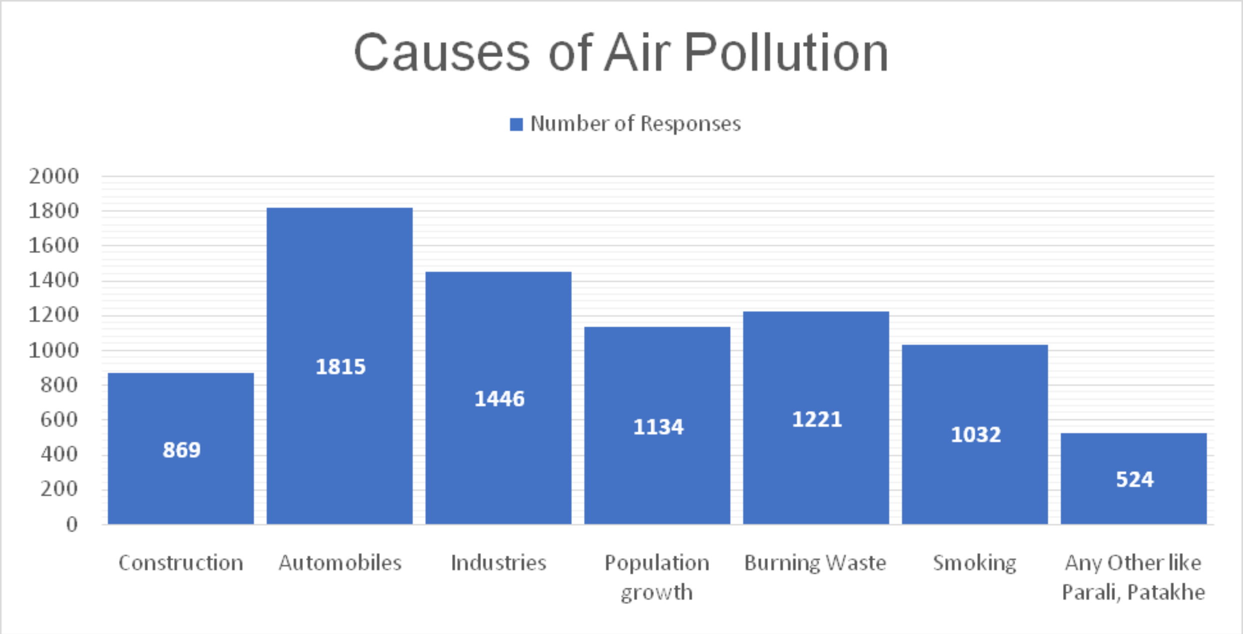


**Fig: 6 Causes of Air Pollution as per the perception of Community**




Majority of respondents have perception that automobiles (96.5%) were major cause of air pollution followed by industries (77%). Only 28% perceived Pareli/Patakhe as cause of air pollution. Other causes of air pollution as perceived by respondents in decreasing order were burning waste (65%), population growth (60%), smoking (55%) and construction activities (46%).

**Table 2: Control of Air Pollution based on awareness of Air Pollution**

| | Aware | Not Aware | Grand Total | Aware% |
|---|---|---|---|---|
| **Considering the factors that cause air pollution, can those be controlled?** | | | | |
| Yes | 1349 | 37 | 1386 | **97.33%** |
| No | 426 | 60 | 486 | **87.65%** |
| Didn't Answer | 3 | 4 | 7 | **42.86%** |
| **Grand Total** | **1778** | **101** | **1879** | **94.62%** |
| ***The two-tailed P value is less than 0.0001 (Statistically significant)*** | | | | |

When asked whether factors that cause air pollution, were possible to be controlled, respondents who were aware about air pollution, around three-fourth (75%) of them responded in affirmative way that these factors could be controlled. Around one-third (36%) of respondents who were unaware about air pollution said that these factors could be controlled. This is attributed to the awareness level of the participants which suggests that more they are aware about the rising menace of Air Pollution,  more they are conversant with the preventive measures.

**Fig: 7 Distribution of Respondents according to Awareness of Air Pollution based on time spent in traffic**

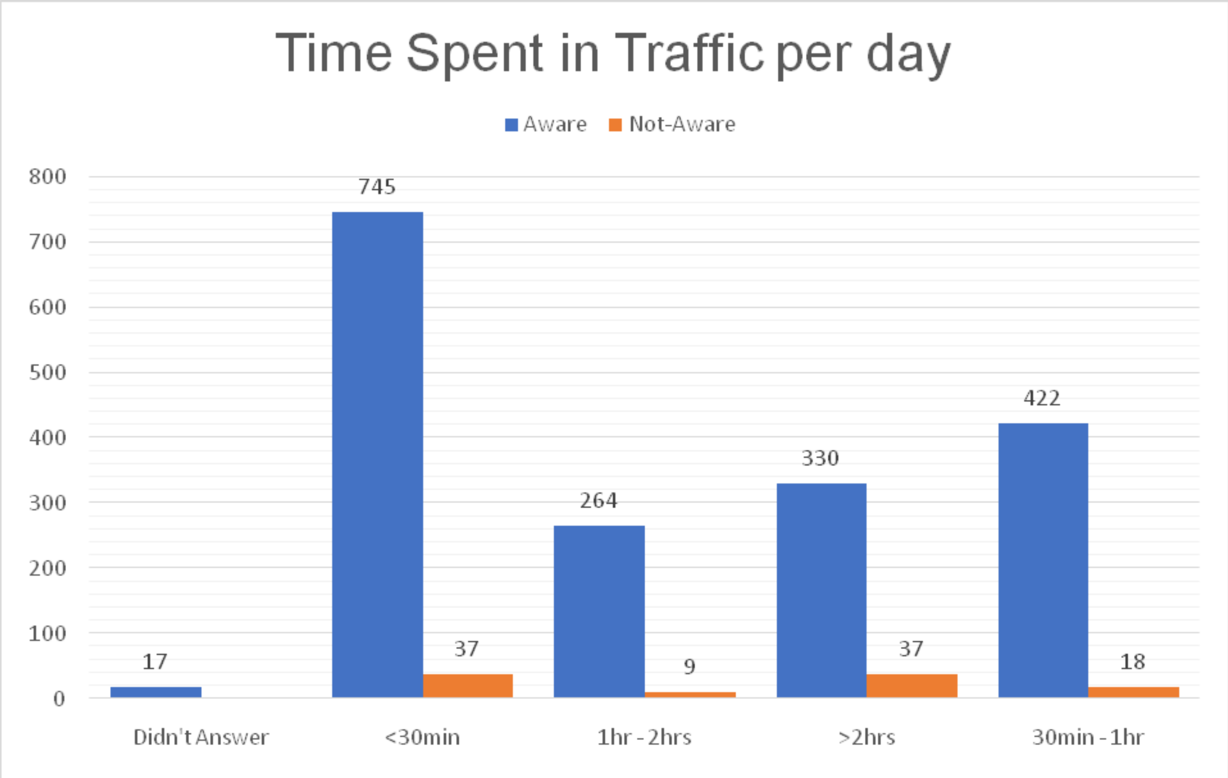



Fig.7 shows the distribution of respondents based on time spent in traffic with awareness regarding air pollution. Awareness levels were almost similar irrespective of time spent in traffic. However, one unusual finding was awareness levels were least among those who spent

>2 hours in traffic as compared to other groups who spent less time in traffic. About 1% of study respondents didn't answer about how much time they spent in traffic.

This suggests that unawareness about Air Pollution is one contributory factor towards spending time in traffic as they are not cautious about the ill-effects of air pollution.

**Fig: 8 Distribution of Respondents according to Awareness of Air Pollution based on presence of industries near the House**

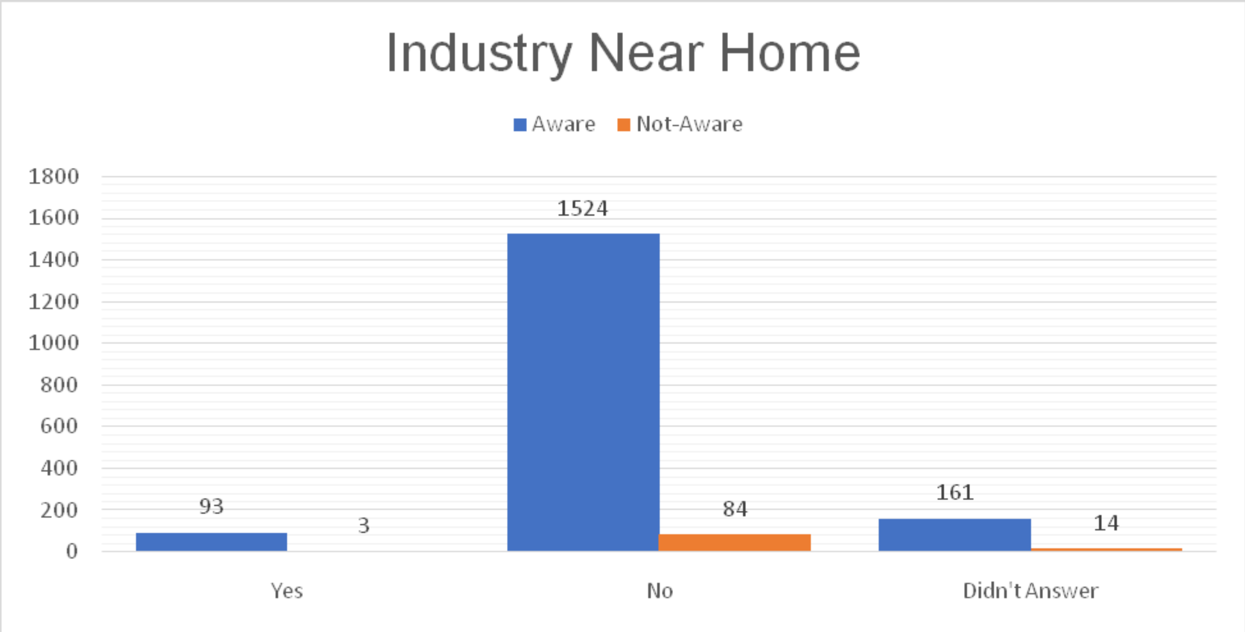
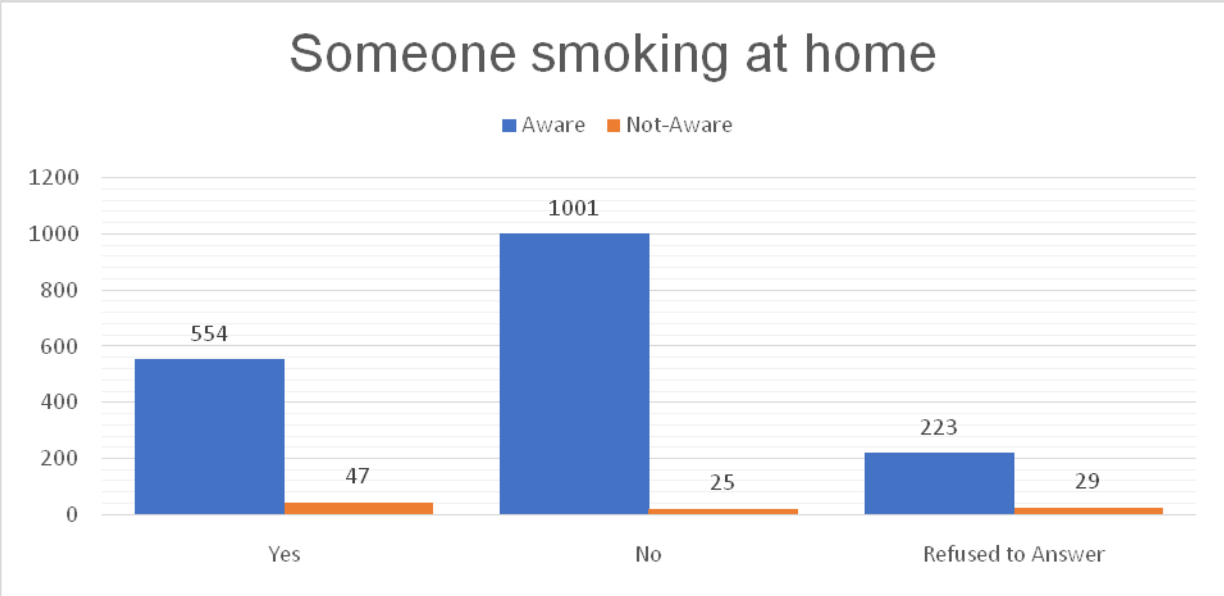



Fig.8 shows distribution of respondents for awareness levels on air pollution on basis of presence or absence of industries near their house. About 86% who were aware regarding air pollution said that they don't have any industry near their house while around 9% didn't answer.

**Fig: 9 Distribution of Respondents according to awareness about Air Pollution based on status of smoking in the Family**




It was observed that amongst those who smoke in the family, 92% were aware about Air pollution whereas almost all of those who didn't smoke were aware of Air Pollution.

The results of the study indicate that educational status alone cannot help in motivating the community in curbing Air pollution. There is need to effectively bring about behavioral change in the community. This is evident from the fact that among the study subjects, majority of the smokers have a significant awareness on health effects of Air pollution, but still were indulged in this risky behavior.

**Table 3. Impact of AQI on acute manifestation of symptoms like Cough, Dyspnoea& Dry throat.**

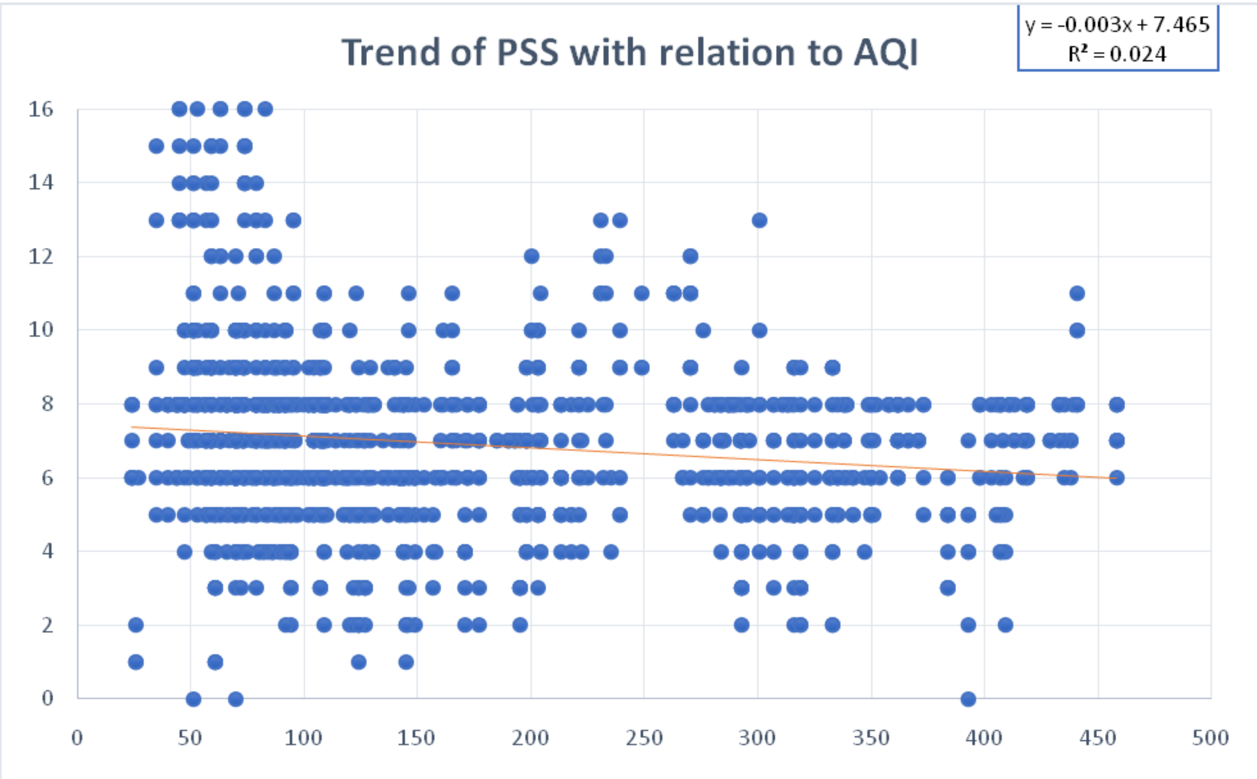
| | Breathlessness <2weeks | Breathlessness >2weeks/No Breathlessness |
|---|---|---|
| **Mean AQI** | 252.94 | 165.73 |
| **Standard Deviation AQI** | 121.82 | 108.46 |
| **Count** | 66 | 1813 |
| **Unpaired t-test two-tailed p-value < 0.0001 (statistically significant)** | | |

| | Cough <2weeks | Cough >2weeks/No Cough |
|---|---|---|
| **Mean AQI** | 186.76 | 162.68 |
| **tandard Deviation AQI** | 115.09 | 107.73 |
| **Count** | 430 | 1449 |
| **Unpaired t-test two-tailed p-value < 0.0001 (statistically significant)** | | |

| | Dry throat <2weeks | Dry throat >2weeks/No Dry throat |
|---|---|---|
| **Mean AQI** | 195.76 | 163.5 |
| **Standard Deviation AQI** | 113.84 | 108.64 |
| **Count** | 291 | 1588 |
| **Unpaired t-test two-tailed p-value < 0.0001 (statistically significant)** | | |

Another important finding of the study was assessed by impact of AQI as a determinant of acute manifestation of physical ailments like Cough, Dyspnoea, dry throat. It was observed that higher AQI was related to acute onset of symptoms like Dyspnoea, cough and Dry throat. This interpretation came out to be statistically significant. This can lead to added stress and reduced work productivity.

## Trends of Perceived Stress Score (PSS) with relation to AQI




The PSS score follows a negative trend with an increase in AQI levels (across all AQI levels). We plotted the same for AQI 0-100 (Good and Moderate), AQI 101-200 (Unhealthy for sensitive groups and unhealthy) and for AQI >200 levels, and the trend with PSS was always observed as a negative trend. As stress is multifactorial and AQI could be a potential contributor for the same, but it alone can’t explain the variability in PSS scores. More data is required to adjust other stressors to find out the true individual effect of AQI on stress levels.

## ***Conclusion***

- The study has been able to generate evidence that cardiopulmonary admissions in Hospitals increase significantly with rising Air pollution. This increase in cardio-pulmonary admissions (Coronary Artery Diseases, Bronchitis, Bronchial Asthma) are directly proportional to increase in AQI and PM 2.5. However, no such relation could be established with Ozone.
- Majority of the respondentsin the Community settings were aware of the rising menace and health effects of Air pollution. With increasing educational status, awareness levels on the quality of Air also increase significantly. The participants belonging to resettlement colonies, slums and JJ Clusters were seen to be having the lowest levels of awareness.
- The results of the study indicate that though education is the key in spreading awareness, educational status alone cannot help in motivating the community in curbing Air pollution. There is need to effectively bring about behavioral change in the community. This is evident from the fact that among the study subjects, majority of the smokers having higher educational background and a significant awareness on reasons and health effects of Air pollution, still indulged in this risky behavior.

Thus, Consistent motivation in terms of rewards, strict legislation including fine and punitive actions, teaching basic behaviors in the school curriculum etc. can act as the drivers of behavior change in the community which was also advised/ recommended by study participants in the community-based data collection.

- Majority of the respondents in the community attributed air pollution to automobiles followed by industries, burning waste, population growth, smoking and construction activities. Few considered Parali/Patakhe(verbatim)as a cause of air pollution.

- Another important finding of the study was assessed by impact of AQI as a determinant of acute manifestation of physical ailments like Cough, Dyspnea, dry throat. It was observed that higher AQI was related to significant increase in acute onset of symptoms like Dyspnea, Cough and Dry throat among the general population residing in areas with higher AQI.
- It was also observed that though air pollution contributes to physical discomfort and respiratory symptoms among the general population, inappropriate behavior along with lack of awareness also puts the exposed population at risk and restricts them from adopting effective measures to mitigate the effects of air pollution.
- This suggests that apart from increasing Cardio-Pulmonary admissions in hospitals, Air Pollution also causes an acute impact on the routine day to day life of the people by causing physical discomfort (Acute Respiratory infections) and also can pose as a risk factor for chronic lung diseases and allergies and asthma. This can also lead to added stress and reduced work productivity.
- The perceived stress levels were assessed amongst the community dwellers using the Perceived Stress scale by computing the individual Scores.These were then plotted for AQI 0-100 (Good and Moderate), AQI 101-200 (Unhealthy for sensitive groups and unhealthy) and for AQI >200 levels. However, a negative trend of PSS was observed with AQI. Since perceived stress is multifactorial and AQI could be a potential contributor, the relationship analyzed between the two cannot be explained. However, the negative relation between the two might explain the poor behavioral adaptation of the community towards preventive measures.
- When the respiratory admissions in all hospitals were compared in Pre-lockdown and lockdown times, a statistically significant decrease in the respiratory admissions in all hospitals cumulatively during lockdown compared to pre-lockdown was observed. The possible reasons can be:

1. Statistically significant decrease in AQI levels during lockdown due to decrease in traffic and industries.

2. Other possibility could be the change in behavior/attitude of the public towards visiting the hospitals, as the fear of getting infected with COVID-19 discouraged them to visit the hospitals/getting admitted in the respiratory wards.

## ***Verbatim probing of Community***

Community emphasized on various roles of Government in controlling Air Pollution like planting more trees, launching odd/even strategy again, increasing cleanliness, strict implementation of laws related to vehicle and pollution control, increasing the employment opportunities, encouraging public transport, decreasing the number of vehicles, measures to stop burning wastes and awareness spreading air pollution control measures.

## ***Policy Implications***

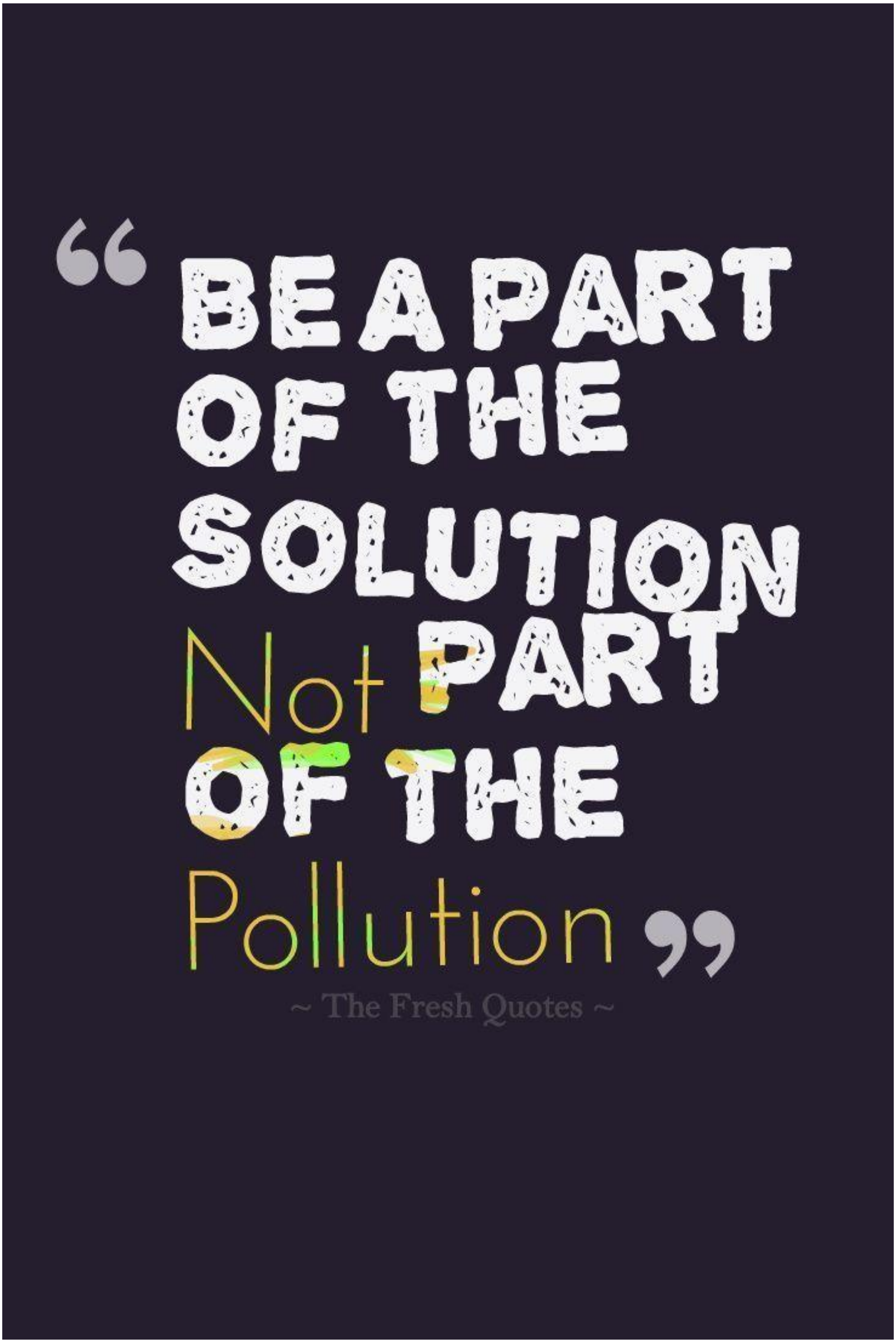
1. **Government Preparedness-**. Government has a significant role in managing the rising menace of Air pollution as well as contributing to preparedness activities to curb the catastrophe.

- Strengthening three tier model for appropriate management of case load
- Gearing up of Health Care system to manage additional load due to Air Pollution
- Exercising stringent laws related to Vehicle and pollution control, implementing strict fines, imposing penalties for offenders
- Addressing areas of self-need and behavioral change
- Encouraging community participation by creating awareness and engaging Community leaders at local levels

2. **Hospital Preparedness-** Since, increasing AQI and Particulate Matter are predisposing people to cardiac and respiratory diseases, the burden on healthcare settings increase. Maintaining adequate and quality records of patients like Occupation, Address, Phone Number to correlate with possible predisposition to common Air Pollutants and adequate follow up; Establishing referral linkages; Generating awareness amongst patients for prevention of Air pollution; Maintaining indoor Air Quality in hospitals; Monitoring AQI near the hospital zones; Setting up of Counselling centers to combat comorbidity induced stress are some measures that can be taken upon to fight the rising trends of Air Pollution.

**3. Community Preparedness:**

- A structured approach to identify & target the population which is aware of air-pollution, yet believe that it can't be controlled
- Innovative and consistent messaging through awareness-campaigns and educational models


"BE A PART
OF THE
SOLUTION
Not PART
OF THE
Pollution"
~ The Fresh Quotes ~