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10 YEARS OF IMPACT AND INNOVATION

Community Perception of Air Quality and its Health Impact

Kolkata Airshed - West Bengal

CONTENTS

SUMMARY

The toll on our lives, economies, and businesses posed by COVID-19 is enormous. Each life lost to COVID-19 is a tragedy stretching our health systems beyond their limits. Like COVID-19, a largely pulmonary disease, has exacerbated the risk of mortality from the prevalence of comorbidity, air pollution too, is gradually emerging as a serious health problem in fast urbanizing world cities.Air pollution in India has been growing significantly surpassing most of the first world countries. In fact, 20 out of the worlds' 30 cities with the worst air quality are in India (IQAir Air Visual, 2019).

The situation in Bengal is equally gruesome. A LANCET-ICMR report of 2020 revealed that air pollution deaths in Bengal were almost 7 times higher than the total number of COVID deaths mourned by the State. The State of Environment Report of 2021 recently published by Centre for Science and Environment uncovered that Bengal had the second highest percentage of deaths in India caused by air pollution in 2019 unnerving an alarm bell for Bengal, particularly Kolkata and other pollution hotspots in the State to take 'urgent action'. A recent CSIR-NEERI Source Apportionment study of 2019 revealed that a quarter of the pollutants in Kolkata's air comes from vehicular emissions making it have significantly high PM 2.5 emissions in comparison to its neighbouring cities.

As striking these figures appear, it is also equally interesting to know that air pollution is solvable and effective precautions can help us protect ourselves better. We just have to stop adding more. As nations across the world went into month's long lockdown and doctors across the world collaborated to battle COVID-19, it has taught us a lesson that rapid responses and high levels of compliance are crucial to drive changes for the betterment of our health systems and to better adapt to our changing environments.

The Bengal Clean Air Network (BengalCAN) under the aegis of Switch ON Foundation, had conducted a health perception pilot study with **2000 low income households (sampled through stratified purposive sampling)** distributed across **Kolkata, Howrah and Barrackpore**, labelled as 'non-attainment cities' in the Kolkata airshed. The study was carried out with the objective **to understand the health perception of the most vulnerable population (spread across age, income, education and occupation levels)** and **find out their vulnerability to air pollution, particularly ambient air pollution.** The perception data was collected based on the recall of the ailments experienced during the period of study i.e. **February - April. 2021 and hence present a subjective study based on individual perceptions**. Some interesting findings from the study have been summarised here in the report.

General Findings

Air pollution impacts the most vulnerable age groups- children and elderly

Air pollution impacts people with low income levels

Perceived health problems vary across occupation, education and living practices

Air pollution impacts the most vulnerable age groups: the young and the elderly

The study shows that two age groups - children below 10 years of age and elderly above 50 years are the most affected by health problems which can be attributable to pollution.

Common respiratory health problems (like sneezing, coughing, sore throat, sinus and nasal congestion)

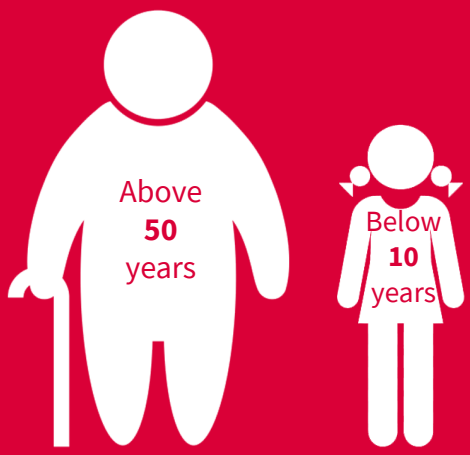
- ***Children below 10 years of age:*** About 3 times more affected than people aged 11-50 years.
- ***Elderly above 50 years of age:*** About 1.5 times more affected than people aged 11-50 years.

Breathlessness and chest discomfort problems in elderly above 50 years of age :

- ***Breathlessness at rest:*** About 5 times more than people aged below 50 years.
- ***Chest discomfort and Breathlessness while climbing*** About 2 times more than people aged below 50 years.

Perceived air quality ad associated health problems vary across occupation, education and living practices

- Drivers perceived air quality to be about 1.4 times worse than that of construction and industrial workers.
- 3 times more people without formal education perceived the air quality to be good as compared to people with formal education.



Air pollution impacts people with low household income

The study shows that health problems attributable to air pollution were highest among households with low income levels and other socio-economic markers like formal education and lifestyle practices.

People earning Rs 5000 or less in a month experienced :

- About 2 times more respiratory health problems than people earning relatively higher.
- Sneezing, coughing and eye irritation as top 3 health problems.
- About 1.4 times higher eye irritation problems than people earning relatively higher.

In line with our study findings, existing literature on air pollution related health consequences show that deaths of children (aged 5-14 years) attributable to ambient particulate matter pollution in West Bengal have increased by 3.5 times in the last 30 years (ICMR). Consecutively, deaths of elderly (aged 50-76 years) attributable to ambient particulate matter pollution have also increased by 2.5 times in the last 30 years (ICMR). This correlates with the findings used in this research that children and elderly are at higher risks of air pollution associated health problems.

Breathlessness or shortness of breath can be strong symptoms linked to underlying diseases like asthma, COPD and poor cardiac conditions which reduces life expectancy and increases chances of premature deaths or all-cause mortality from age 55 until death. (Pesola, G.R, 2016; Sandberg J.et.al, 2019; WHO Global Health Observatory, 2018). Our study had a clear narrative that elderly above 50 years of age are more likely to succumb to breathlessness problems which could have been caused from a multitude of pollutants present both in indoor as well as outdoor environments.

Inequality research on exposures to polluted air done globally have shown that ambient air quality in environments occupied by lower income communities can be significantly poor. (Egondi. T, 2013; Atari DO, 2009). This set became our prime motivation to understand the vulnerability trajectories of low income households. The study revealed that people earning less than 5000 Rs per month were most affected by air pollution related health problems. Low household income can aggravate household vulnerability in terms of increased risk of contracting health problems attributable to air pollution and indirect impacts like reductions in human and physical capital, access to healthcare, education etc. that further exacerbates their vulnerability (Yang.Z. et.al, 2021; Lipfert, F. W. 2004, Li, H. B., & Zhu, Y. 2006).

Levels of formal education and the type of occupation can impact communities' perception of air quality (Saksena, S, 2003; Goodman. A, 2011). Lack of awareness can be also be potentially linked to their lifestyle practices and poor precautionary measures undertaken (Ramirez. A.S et.al 2019, Cisneros R, 2018, D'Antoni D et.al, 2017). In our study, this could be seen through the perception data captured which states that more number of people without formal education consider air quality to be better than rest of the population.

Way Forward

Address and improve air quality as per National Clean Air Plan (NCAP) target

It is critical to start identifying air pollution as a major health problem and develop and implement immediate mitigation measures.

Increase public awareness on air pollution

Campaigning activities, knowledge dissemination on daily air quality through media etc. cmust be undertaken to improve public awareness of the issue.

Switch to sustainable transport

Incorporation of bicycles, non-motorised transport and electric vehicles can help make a clean mobility shift.

Introduce preventive health care interventions

Air pollution pose an unanticipated health threat which might be heavier than COVID-19. Preventive health care interventions must be undertaken to protect the health care system

CHAPTER I

Context

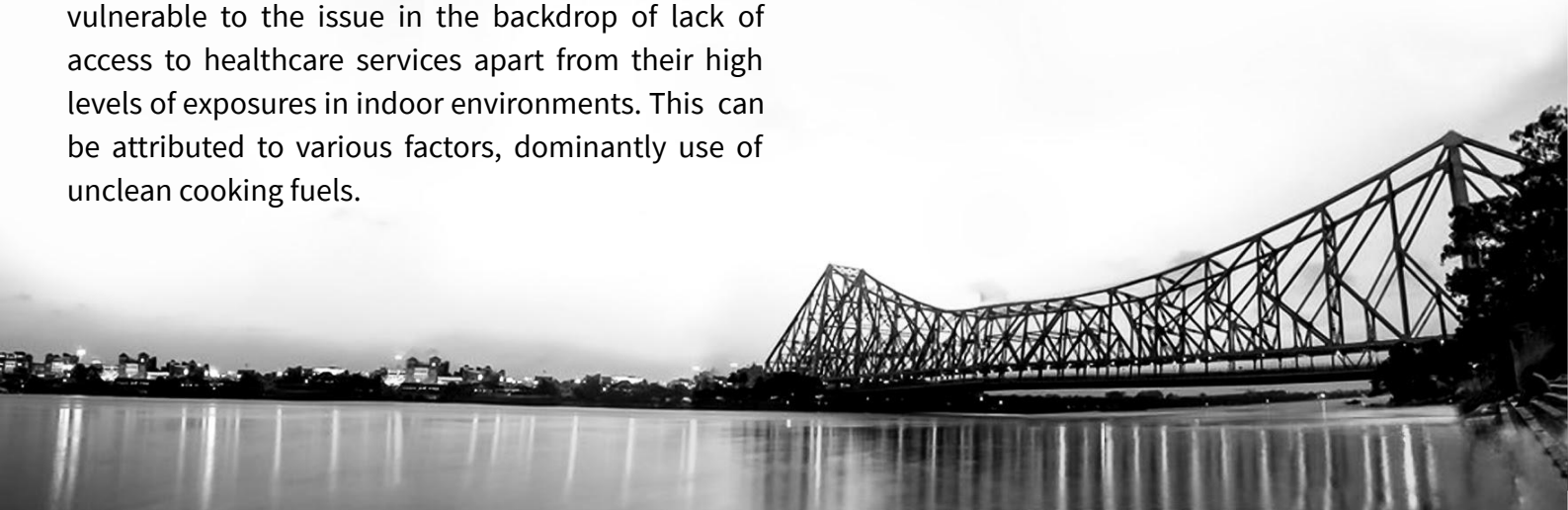
Context

Long-term exposure to major air pollutants can cause severe health impacts. Polluted air contains harmful substances that can travel deeply into the respiratory tract and sit in the lungs for several years (Pascal et. al, 2013; Maji et. al, 2017, Alberni et.al, 1997). Air pollution is causing the greatest threat to human health because of its interlinkages with several diseases like cardiovascular mortality, respiratory mortality, cancer, COPD, asthma, etc. (Pope et al., 1995; Sunyer et al., 1997; Brunekreef and Holgate, 2002; Brunekreef, 2010; Correia et al., 2013; Averett, 2015; Barrett, 2015). The list is endless and several other associated diseases like skin ailments, neurobehavioural and miscellaneous health disorders can also be linked to prolonged exposures to harmful pollutants.

Over the last couple of decades, rapid urbanization coupled with an industrial boom has posed huge challenges of balancing economic development with environmental security in the majority of Indian cities. This has, over the years, drawn thousands of populations from the neighboring rural and peri-urban areas in search of better economic opportunities. They often settle in shanty slum settlements with poor living conditions, putting extra pressure on existing natural resources (Hardoy et al, 2001; UNCHS, 1996, Ali, 2003, Dasgupta, 2014). Coupled with the already existing health challenges faced by them as a result of poor and compact living conditions, research has revealed that people living in urban shanties are more exposed to ambient air pollution and more vulnerable to the issue in the backdrop of lack of access to healthcare services apart from their high levels of exposures in indoor environments. This can be attributed to various factors, dominantly use of unclean cooking fuels.

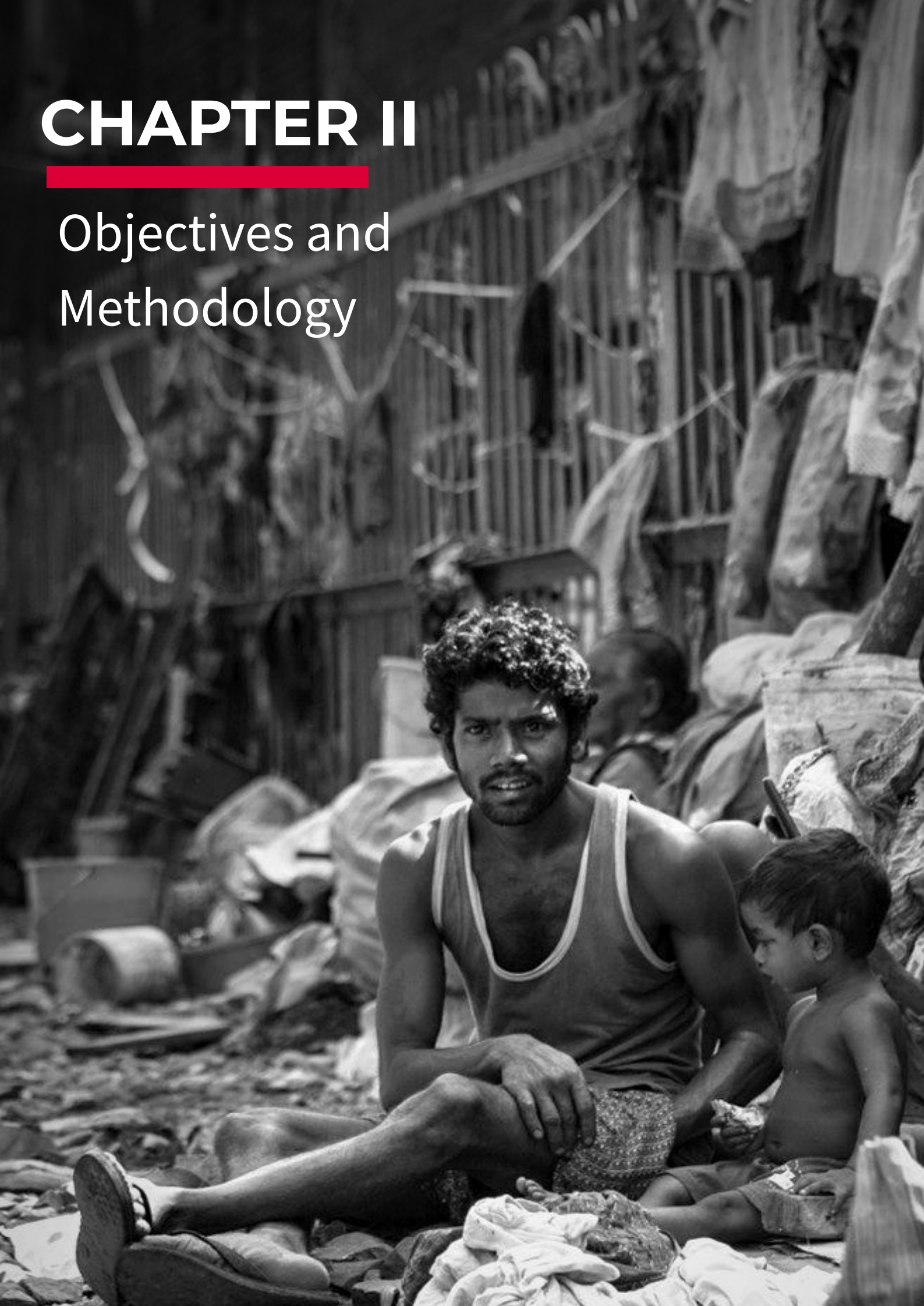
Apart from industrial and household pollution, vehicular air pollution has also increasingly become the main source of urban air pollution, particularly in developing countries where the fleet of private cars and motorcycles is expanding rapidly, and travel distances also increase due to urban expansion and the emergence of suburbs and satellite towns. In almost all Indian cities, the majority of the population is exposed to ambient air pollution (Lancet, 2020) and people living in poor living conditions are more exposed and hence more vulnerable to the issue.

Apart from that, people in certain professions like drivers, construction, and industrial workers are more exposed to ambient air pollution as a result of spending long time periods in urban congested spaces (Shanon Lim, 2021). Similarly, exposure to indoor air pollutants is also considered to be the highest in compact spaces and where pollutive fuels are used for cooking or heating purposes such as coal, fuelwood/ biomass, and kerosene. Household exposures to emissions from unclean fuel combustion in urban areas are therefore noticeable highest among slum populations (WHO, 2005). The most affected by indoor air pollution are women and children below 10 years of age because of the majority of their time in indoor environments and exposed to various forms of indoor air pollutants such as cooking exhausts, smoke from insecticides, incense sticks, etc. (Lakshmi PV et al. 2013, Maharana SP et al. 2018)



CHAPTER II

Objectives and Methodology



Objectives and Methodology

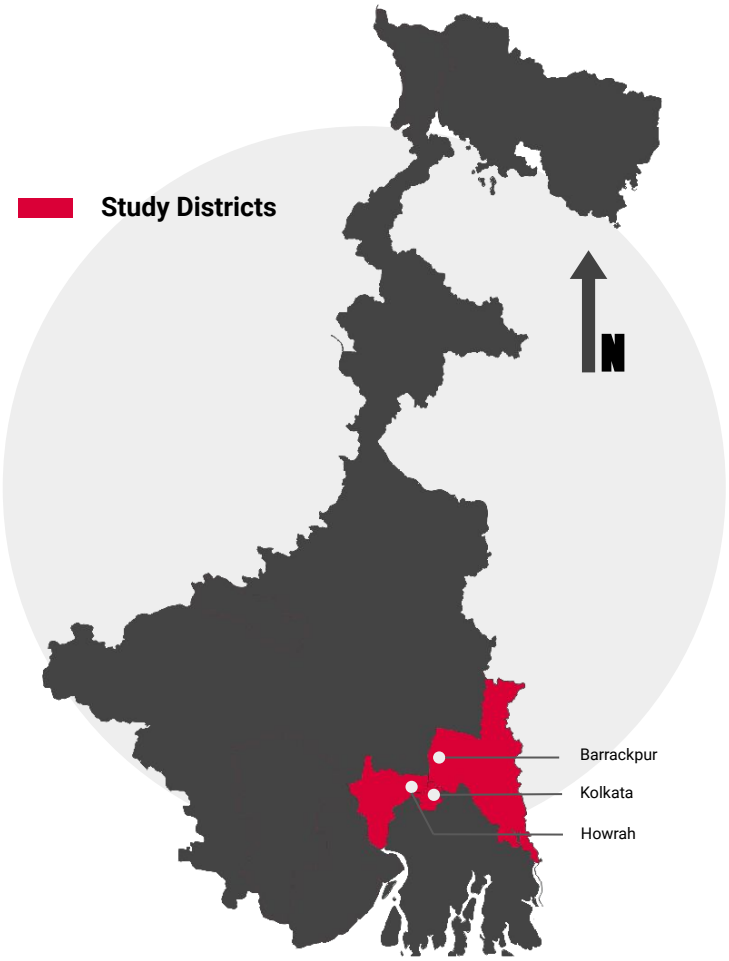
The health risk of pollution rises as outdoor air pollution rises. Most vulnerable among them are children and the elderly with pre-existing health conditions. Understanding the perceived health risk of air pollution is important to document as it is critical to design interventions for the most vulnerable communities and address gaps in bringing behavioral change among the populace as health policies are designed.

Objectives

The objective of the study is therefore to identify the following -

- To find out the most vulnerable population exposed to ambient air pollution
- To establish perceived air pollution-related health problems across all socioeconomic backgrounds.

Study areas



Materials and Methods

The study was conducted across **the Kolkata airshed.** This includes three among the seven non-attainment cities across West Bengal i.e. **Kolkata, Barrackpore and Howrah.** West Bengal currently has seven nonattainment cities namely Kolkata, Haldia, Howrah, Barrackpore, Raniganj, Asansol, and Durgapur. These cities had been enlisted as non-attainment cities by the National Clean Air Programme (NCAP) in the year 2017 which was started by the Central Pollution Control Board (CPCB). These cities have been tagged as non-attainment cities because they have not been able to maintain the emissions standards set by the Board for 5 consecutive years.

The study was conducted in slums and shanty settlements located across the airshed.

The sample study areas were chosen randomly from across the city with the help of Google Earth Pro which was well representative of the entire airshed.

Sample and Sampling design

A stratified purposive sample of households from each city has been selected making a total sample size of **2000 households** from the 3 nonattainment cities studied. All the non-attainment cities coming in the airshed except for Haldia were included in the sample. This is so because data collection from Haldia was stalled with the onset of the second wave of COVID-19 in the State from March 2021 onwards.

The target group kept for the study were the population who are most vulnerable to ambient air pollution and most likely to be affected i.e. **children below 10 years of age and elderly above 50 years of age** and people who belong to the **occupation category of construction/ industrial workers and drivers**.

The sample of respondents was then stratified equally based on age and occupation categories. The rationale behind stratifying the sample purposely was to analyze the impact on health across several age groups and occupation categories by forming homogenous groups of samples.

The rationale behind stratifying the sample based on occupation categories was to maintain homogenous samples for drivers and construction/ industrial workers who are most exposed to ambient air pollution. **The larger rationale behind having children below 10 years of age and people working as drivers and industrial workers is that they are most vulnerable to outdoor particulate matter pollution.**

Outliers in the sample were omitted after data collection to maintain the same sample size across all age categories.

Airshed : Kolkata

Non-attainment cities name	No. of Surveys Completed
Kolkata	1030
Howrah	170
Barrackpore	800

Total No. of Surveys Completed : **2000**

Total No. of Non-smoking population studied : **1786**

Data collection and analysis

Heath perception data:

A mixed methodology approach has been deployed for data collection. Health perception data from households was collected with the help of volunteers. Data was collected from the period February to April 2021 using ODK Collect. Volunteers were trained with the interview schedule and the interview schedule was pre-tested with pilots. Every 3rd or 4th household was surveyed in each lane of the settlement.

Air Quality Data:

Air Quality Data was collected from the CPCB data portal for Kolkata and Howrah in the airshed studied. This data was then analyzed in MS. Excel by collating and categorizing city-specific air quality data in Kolkata airshed. The rationale behind adopting an airshed approach and not going for individual analyses of the air quality in the cities was to account for all data gaps in specific cities. Since cities in one airshed are within 10-20 km distance from each other, the adoption of an airshed approach makes more sense than regional analyses of air quality as all cities in one airshed experience similar air quality.

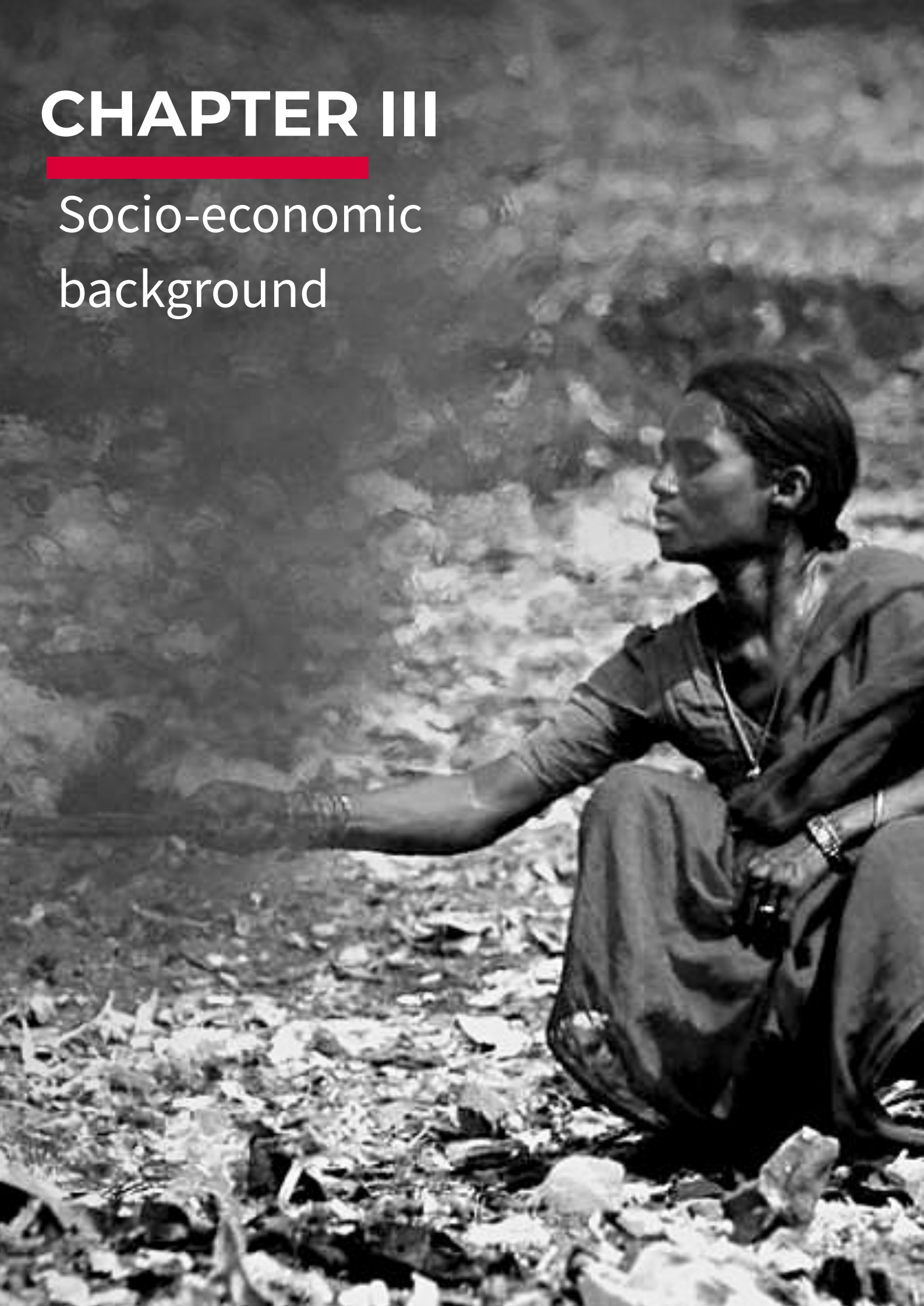
Limitations

Due to the prevalence of COVID-19, pulmonary function tests (PFT) could not be conducted and a **health perception study** was conducted. Hence, direct causation could not be drawn between air pollution and the perceived health problems experienced over the last month have been shown which could be subjective. The prevalence of the pandemic during the data collection process may have biased the perception data to some extent and perceptions may vary across regions and social backgrounds.

NOTE : ***CPCB Data Portal*** *- app.cpcbccr.com /ccr/#/caaqm-dashboard-all/caaqm-landing*

CHAPTER III

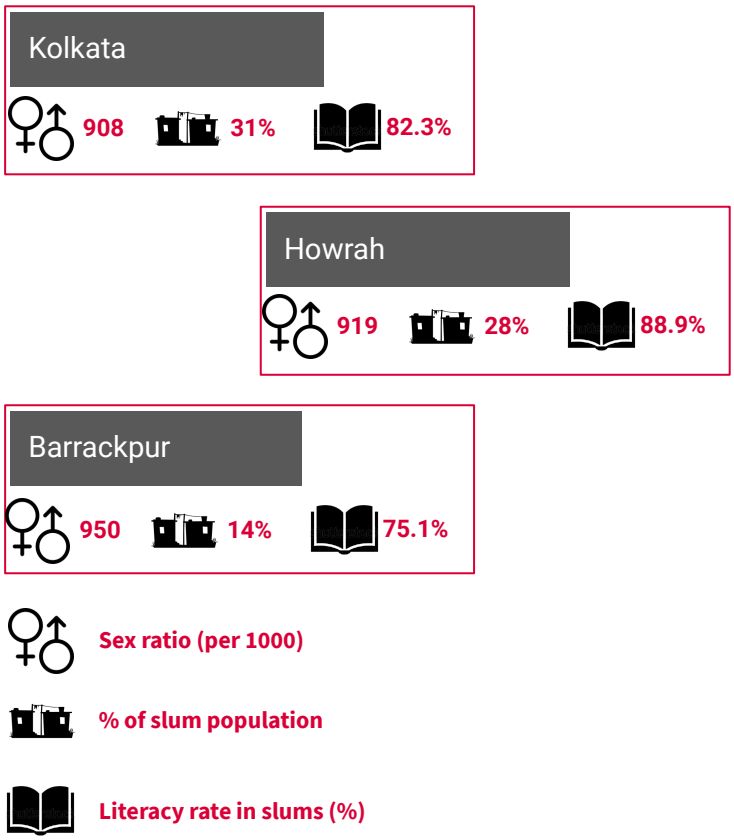
Socio-economic background



Socio-economic background

The non-attainment cities studied in Kolkata airshed had a dominance of commercial and industrial economy types in Kolkata and Howrah while agriculture was more dominant of Barrackpore's economy . The majority of the cities in the airshed had a high dominance of urban population in Kolkata and Howrah while it was relatively less in Barrackpore. The sex ratio of 908 per 1000 males which was significantly higher in Barrackpore as compared to Kolkata and Howrah. The percentage of the slum population was also highest in the cities of Kolkata as compared to Howrah or Barrackpore.

This is so because Kolkata being major commercial hub and the capital city of West Bengal experience a heavy inflow of rural and peri-urban migrants who come in search of better economic opportunities and settle and shanties and slums.

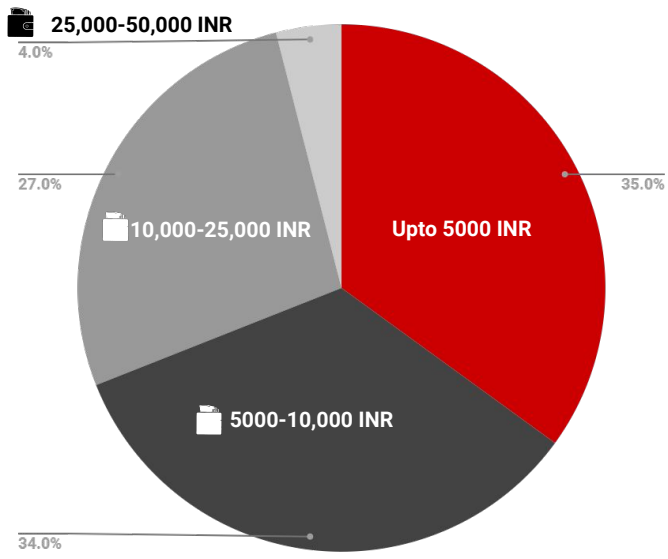


Economic characteristics and patterns of fuel use

It was observed that the majority of the population studied belonged to the income category of up to 5000 Rupees as the family income earned in a month, followed by the income range of Rupees 5000- 10,000. 35% of the population in the cities of Kolkata airshed belonged to the monthly income category of less than Rs 5000 per month which was the highest.

Very few belonged to the income category of more than Rs 25,000 in a month. This manifests that the majority of population studied for the purpose of the study belonged to the Below Poverty Line (BPL) category.

Economic characteristics of the population studied



Family income/ month (in Rs.)
Kolkata airshed

CHAPTER IV

Trends in air quality of Bengal

Trends in air quality of Bengal

Pollution trends in India: Bengal rising at par with top polluted Indian cities

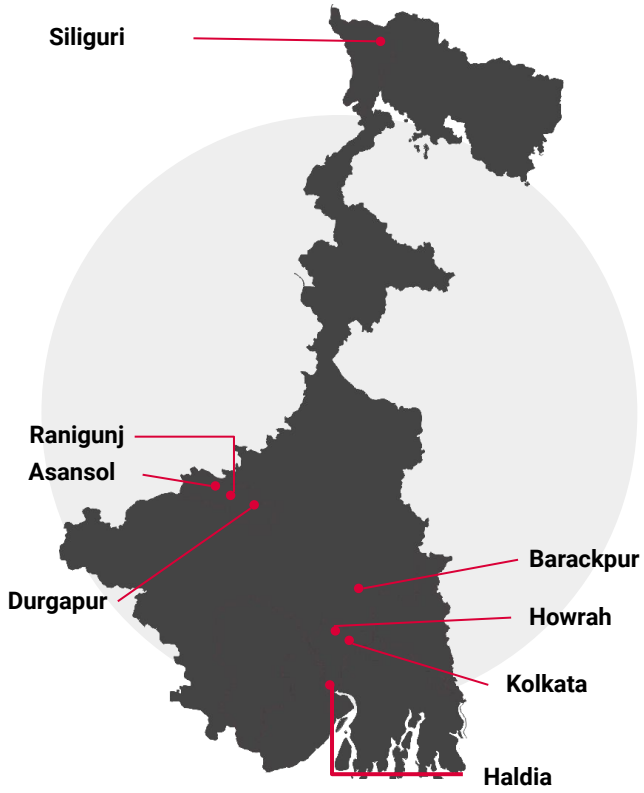
India has been designated with the worst air quality levels globally. According to WHO, 2018, in India, 13 cities have made it to the world's top 20 worst air polluted cities. With rapid levels of urbanization and industrial expansion, air pollution is soon going to emerge as a major health risk for the country's massive population.

A Lancet-ICMR Report in 2019 uncovered that about 1.7 million people in the country have passed away due to air pollution in 2019. Air pollution in India has regional ramifications which are most potent over the Indo-Gangetic plain, spanning approximately over 45–50 cities across the states of Assam, Bihar, Haryana, Jharkhand, Madhya Pradesh, Punjab, Rajasthan, Uttarakhand, Uttar Pradesh, and West Bengal (National Clean Air Programme, 2013). Bengal was the fourth Indian state that recorded about 1,22,833 deaths in 2019 which is even higher than COVID-19 deaths in the State. In fact, West Bengal saw more deaths from household air pollution in the under 5 categories than in Delhi and Haryana, where the air quality is regarded to be the worst across the nation (Lancet-ICMR). Additionally, transport emissions from fossil fuel combustion contribute to about 25-30%, found a West Bengal Pollution Control Board (WBPCB) commissioned source apportionment study despite the State having multiple public transportation options (NEERI Source Apportionment Study, 2019).

Non-attainment cities in Bengal

The Central Pollution Control Board (CPCB) has designated several cities across the nation as non-attainment cities under the National Clean Air Programme of 2017 and has set stringent targets of a minimum of 30% reduction in the quality of air by 2024 from the 2017 levels.

The city which consistently does not meet the National Ambient Air Quality Standards (NAAQS) for PM 10 (Particulate matter that is 10 microns or less in diameter) or NO2 (Nitrogen Dioxide) over a duration of the 5-year period is declared as a nonattainment city. There are 7 such nonattainment cities in West Bengal - **Durgapur, Asansol, Howrah, Kolkata, Haldia, Raniganj, and Barrackpore.**



Trends in ambient air pollution in Kolkata airshed :

The NEERI-CSIR study of 2019 reveals that two main cities of West Bengal which contribute vastly to the state's air pollution levels are Howrah and Kolkata. The coarser particulate PM10 has been emitted mostly through vehicular pollution (around 22% contribution) and through secondary aerosols (around 20% contribution) in both these cities (CSIR-NEERI, 2019). Other sources of PM10 include from construction businesses, road dust (20% & 9% contribution in Kolkata and Howrah respectively), wood combustion, coal combustion, and kerosene burning (CSIR-NEERI, 2019).

The more harmful and finer particles of air pollutants are PM2.5 which can easily get into the lungs and cause various long-term respiratory diseases. In Kolkata, the largest contributor to PM2.5 is vehicular pollution (22%) and coal combustion (22%).

Secondary aerosol also tops the chart with a 20% contribution to air pollution in the city. In the city of Howrah, secondary aerosol contributes 28%, vehicles 19%, and wood combustion 20% to the overall pollution levels. Here agricultural waste burning also forms 8% of a contributor.

PM2.5 can easily get into the lungs being tiny particles and cause various long-term respiratory diseases.

It has been proven that during the winter months the aerosol accumulation in the atmosphere is the highest when compared with other seasonal months like summer due to several activities like open burning of agricultural waste, trash etc. It could also be, during summer, the lowest layer of the atmosphere is warmer and lighter as compared to winter, which makes it easy for air to rise upwards. As a result, the pollutants are carried away from the ground. However, during winter, the air near the atmosphere of the earth is dense and cooler. Hence during winters, the pollutants stay right above the ground surface. A quarter of pollutants in the state's capital city of Kolkata is contributed by vehicular emission, especially in winter months.

An analysis of the air quality data of 2020 from the available data in the CPCB portal in the city of Kolkata and Howrah shows that PM 2.5 concentrations have been significantly higher than in both Kolkata and Howrah, exceeding far above the national limits set by CPCB. For Kolkata, trends in air quality in the Rabindra Bharati University (RBU) station was studied while trends in air quality in Howrah-Ghusuri was analysed The average winter PM 2.5 concentrations in Howrah in the year 2020 was 140 µg/m3 while it was 136 µg/m3 in Kolkata which are about more than double the national standard set by CPCB.

A dip in the PM 2.5 concentrations and concentrations of other harmful gases like N02, SO2 and Ozone could be observed in the summer and post-monsoon months across both the cities of Kolkata and Howrah which were also lockdown months in the State as a result of the COVID-19 pandemic spread. The peaks in the concentration could be seen in the early winter months starting from January as well as the late winter months with cities in the Kolkata airshed recording the highest peak. It is important to note here that continuous air quality data for the year 2020 were not available for Haldia and Barrackpore.

It was found that both the concentrations of NO2 and SO2 were about 1-2 times higher in the city of Howrah

Both Nitrogen Dioxide (NO2) and Sulphur Dioxide (SO2) produced by burning fuel for vehicles, power and industrial production can be attributed to cause severe respiratory health problems and has been even labelled as a cause of death when the annual average of 40 micrograms (one-millionth of a gram) per cubic meter of air (µg/m3) is exceeded. In our air quality analyses, it was found that both the concentrations of NO2 and SO2 were about 1-2 times higher in the city of Howrah being a major transportation and industrial hub in Bengal than in the city of Kolkata. While average NO2 concentrations in Kolkata were within limits in the year 2020 which could also be due to the COVID-19 induced lockdown effect, in Howrah, it exceeded the prescribed safe limits by a few points.

CHAPTER V

Trends of air quality in Bengal

Community perceptions of air quality

Air pollution can have multi-faceted impacts on human health. It can impact human health differently depending on various socio-economic parameters such as age, gender, occupation, cooking techniques used within the household, practices that inhibit indoor smoke, etc. For our study, we have tried to bring in all possible parameters to help us understand the various impacts of air pollution based on the levels of exposure and sensitivity of the people.

To understand how the poor are the most vulnerable sections of the society in terms of their highest exposure to vehicular emissions from outdoor environments, we studied the relation between income, age, occupation and education levels and their independent perception of health problems. The health perception data of the three cities were grouped together to study the cumulative perceptions of the entire airshed.

Perceived respiratory health problems across age groups

It is well established through existing literature that urban poor populations who dwell in shanty slum settlements without proper living conditions close to roads are more exposed to ambient air pollution from their immediate environment. For fast urbanizing cities like Kolkata and Howrah, vehicular pollution is a major contributor to ambient air pollution. Chattopadhyay, B.P. (2007), in his study in Kolkata has shown that the ambient air of Kolkata has an alarmingly high level of PM10 and the level showed an increasing trend. Though there are different sources, vehicular exhaust is the major contributing source for PM and Volatile Organic Compounds (VOCs) pollution in the city which can have a potential impact on health of the general population.

In a similar study conducted by Goyal et. al, 2011, it was well established that in urban environments with highest exposure to emissions from vehicles exhausts, indoor concentrations of PM 2.5 and PM 10 can also be attributed to vehicular pollutants in classroom environments that filter through open windows and airways.

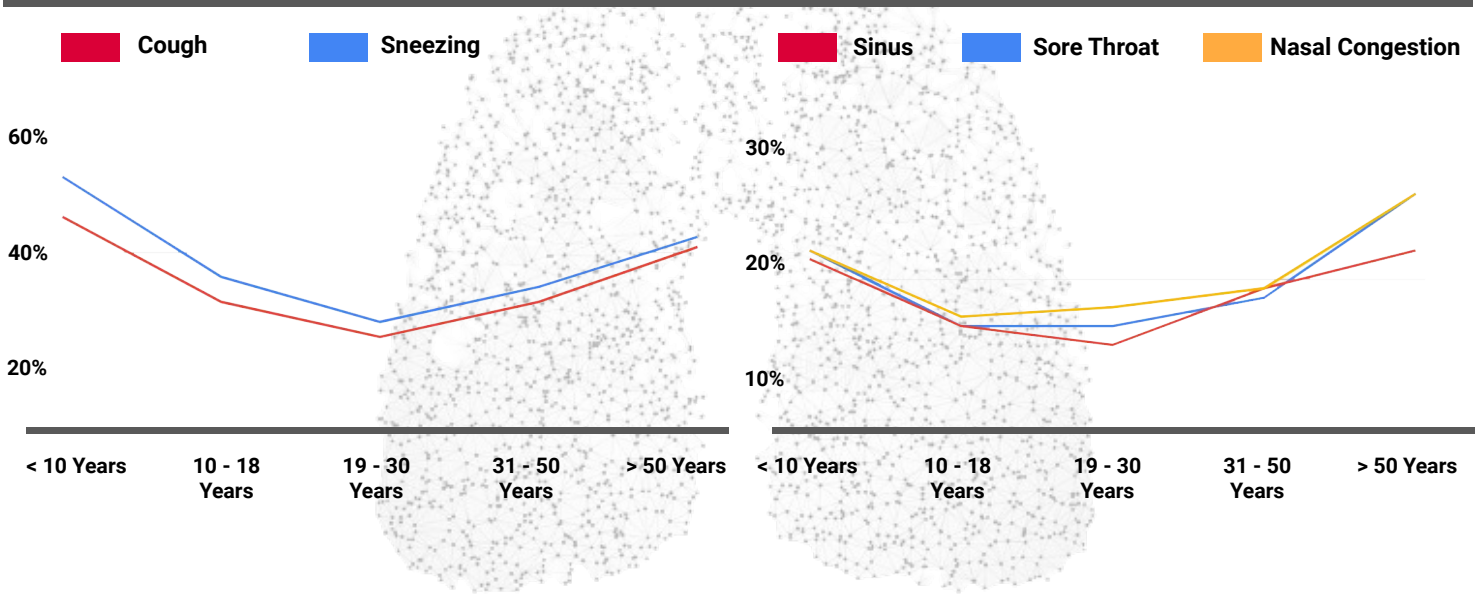
Several other studies conducted across various other metropolitan cities have revealed that every little increase in the concentrations of particulate matter in ambient air is strongly associated with greater number of hospital visits with common health problems which can also have a potential impact on the rates of mortality (Rajarathnam et.al, 2011; Nidhi et. al, 2007). A recent Lancet ICMR study of 2019 also revealed that nationally in India about 0.98 million deaths were attributable to ambient air pollution and indoor air pollution related deaths decreased by 64.2%.

Similar studies conducted in Kolkata in the slum settlements revealed that a household's vulnerability to different sources of pollution eventually accentuates in lower income communities.

having poor conditions of living with ill-ventilated rooms that can trap both indoor and outdoor air pollutants and depends largely on households level of awareness and income that further manifests vulnerability. (Muindi.K, 2016; Maharana. S.P, 2018)

Lancet ICMR study of 2019 also revealed that nationally in India about 1 million deaths were attributable to ambient air pollution

Figure 1: Percentage of people experiencing health problems across age groups
(Refer to Table 1 and 2 in the Annexure)

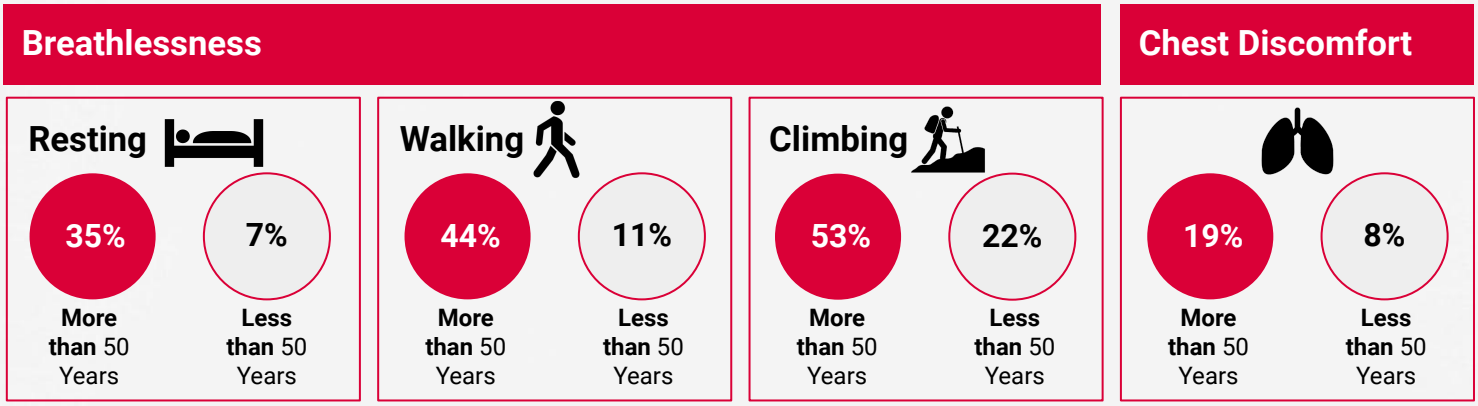


Two most common respiratory health problems experienced by the people is coughing and sneezing

It was observed that children below 10 years of age and elderly above 50 years of age were about 10-20% more affected by respiratory health problems like sneezing, coughing, sore throat, sinus and nasal congestion (Fig 1).

This could be due to several factors attributable to lifestyle practices (such as smoking indoor, use of incense sticks, pesticides etc.), use of unclean cooking fuels and exposure to ambient air pollution coming from dust or vehicular emissions which can easily enter indoor environments due to the household's proximity to roads or polluted environments like dumping grounds, industries etc.

Figure 2: Percentage of people experiencing health problems across age groups
(Refer to Table 3 in Annexure)



It was also observed that breathlessness was most common among the elderly above 50 years of age as compared to the younger age groups (Fig 2). Population of more than 50 years of age have experienced 5 times higher breathlessness at rest and 4 times higher breathlessness while walking 4 times higher than the population less than 50 years of age (Fig 2). Chest discomfort and breathlessness while climbing experienced among people more than 50 years old were double than that of people less than 50 years old.

Higher prevalence of breathless among the children and the elderly can be attributed to a higher risk exposure to indoor air pollution than in the rest of the exposed population (Bentayeb. M, 2013).

Increase in particulate matter in the air can also be directly linked with fossil fuel combustion on the roads, through vehicle exhausts, neighbouring factories/ industries and open burning of coal in roadside eateries which in our study area was a quite potent factor to consider.

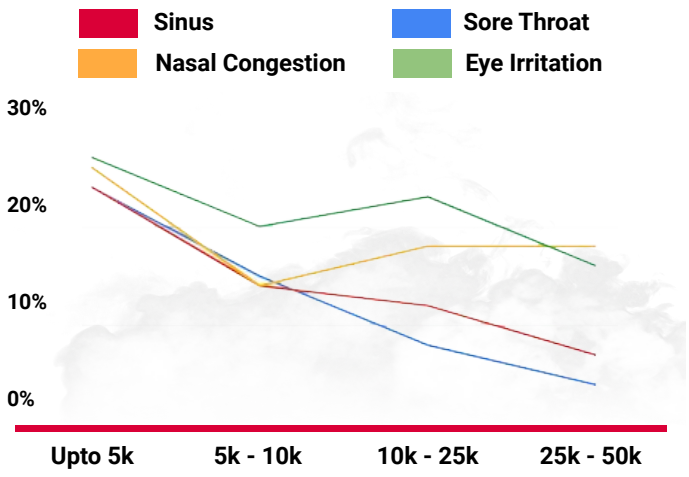
Breathlessness and chest discomfort which are both symptoms of asthma are largely caused as a result of blockage of airways with the inhalation of soot, VOCs or heavy suspended particulate matters in the air that comes from vehicle exhausts and can penetrate into indoor environments in compact living conditions (Kopnina. H, 2015; Baer, H., 2009.).

Perceived health problems across income groups

Several researches have shown that the ambient air quality in environments occupied by lower income communities can be significantly poor attributable to proximity to industries, dust from unpaved roads, poor waste disposal, automobile emissions, burning of trash and heavy use of solids fuels such as charcoal and wood (Egondi. T, 2013; Atari DO, 2009) Less family income increases the vulnerability to health problems experienced which can be a clear indication of lifestyle habits and the standard of living.

It was observed that people with a monthly family income of Rs 5000 or less experienced health problems 2 times more than people in relatively higher income groups (Fig 3). Highest health problem recorded among people earning less than Rs 5000 was eye irritation which could be linked to exposure to high pollutants in indoor environments or exposure to outdoor air pollution in terms of occupation or place of residence (Fig 3 and 4).

Fig 3: Percentage of people experiencing health problem across income groups
(Table 4 in Annexure)

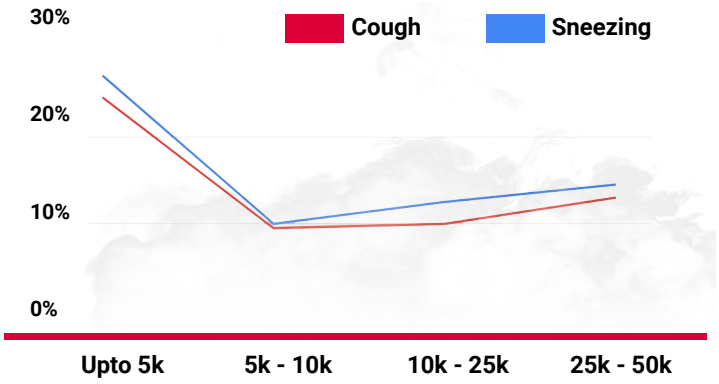


The sampling distribution was spread across people from different income groups to study the impact of ambient air quality across different levels of family income and understand how vulnerability to exposure to outdoor air pollutants can be associated across all levels of earnings. Disparities in outdoor air pollution exposure between individuals of differing socio-economic status is a growing area of research, widely explored in the environmental health literature.

Recently, studies carried out in developed countries have revealed that socio-economic status of the household can significantly impact the household's vulnerability in terms of increased exposure to both indoor and outdoor air pollutants. In terms of exposure to outdoor air pollution, a household's socio-economic status can impact the location of the household, the house type (with or without exhausts) and living conditions that promote the entry of outdoor air pollutants from close proximity. Households located close to main roads are often polluted by traffic-related air pollutants like black carbon (BC), carbon monoxide (CO), and nitrogen dioxide (NO2)—all of which have been associated with adverse health effects including the increased risk of cardiovascular diseases, stroke, and reduced life expectancy (Baccarelli A, 2009, Hock. G. et.al, 2002, Hitchen. J. et.al, 2000)

It was observed in our study region that of the total population surveyed in the airshed, only 18% of the households had separate kitchen while only 4% had an exhaust attached to their kitchen. While this can be a clear indication of household's poor socioeconomic status, it also implies that in the absence of proper ventilation, a complex mix of both indoor and outdoor air pollutants can manifest the vulnerability of household in terms of their exposure to ambient air pollution.

Fig 4: Percentage of people experiencing health problem across income groups
(Table 5 in Annexure)



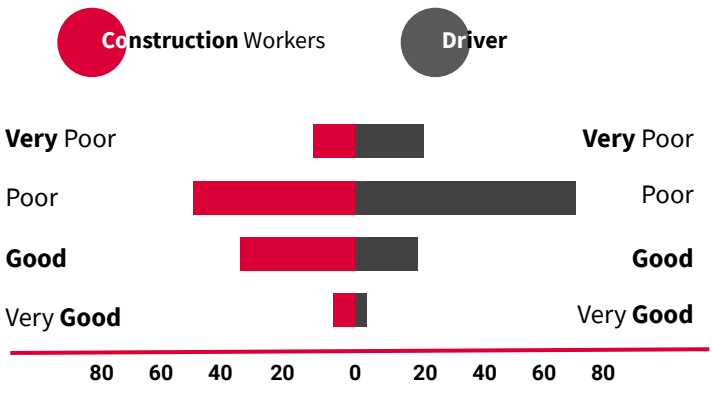
It could also be observed that sneezing and coughing among the population earning a monthly income of Rs 5000 and above were consistently spread out as compared to the population in the income group of below Rs 5000 per month experiencing sneezing and coughing problems during the study period.

Perception of ambient air quality across occupation groups

Various studies revealed that motor vehicle emissions are the combination of various pollutants which have the potential to result in adverse health effects, including carcinogenicity, mutagenicity, cardiovascular mortality and the aggravation of the health of the vulnerable group such as people with compromised health conditions like the asthmatics, children and elders. The acute exposures have resulted in hospitalization due to respiratory conditions while health effects such as carcinogenicity, mutagenicity, cardiovascular health conditions lead to chronic exposures (Khandar and Kosnakar, 2014).

The study focussed on understanding the perceptions of ambient air quality among the lower income communities in the airshed. It was observed that majority of the population believed air quality to be poor and it was about 1.3 times higher than construction and industrial workers (Fig 5).

Fig 5: Occupation group perception of ambient air quality
(Refer to Table 6 in Annexure)

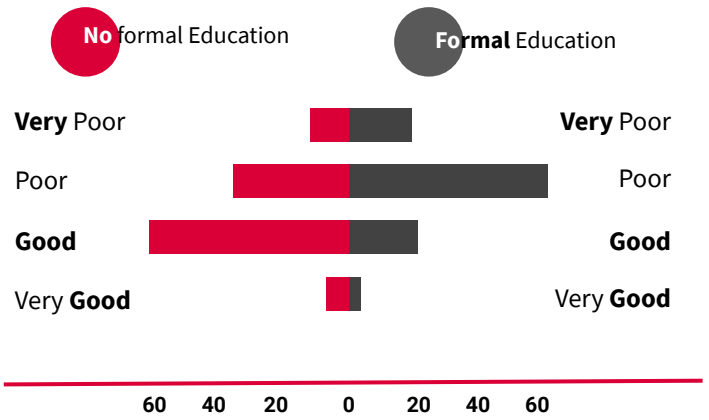


In fact, construction and industrial workers perceived air quality to be about 3 times better than that of drivers. This clearly indicates that more number of people in the study region considered vehicular pollution to be more than industrial pollution or pollution from construction sites.

Some studies conducted in US and China with heavy traffic flows have shown that traffic congestion can increase risks for individuals driving on freeways and arterial roads, and for individuals living or working near roads in terms of prolonged exposures to vehicular exhausts (Zhang. K, 2013; Young-Hee Ryu, 2020).

Perception of ambient air quality across education groups

Fig 6: Outdoor Air Quality Perception of people with various educational level
(Refer to Table 7 in Annexure)



It was observed that 3 times more people with no formal education perceived the air quality to be good as compared to people with formal education (Fig 6). This is an indication that levels of literacy can impact communities' perception of air quality as air quality can be poor even when it is not clearly visible and felt. This indicates that the level of awareness on outdoor air quality is quite poor as the majority without education tend to perceive the air quality to be good. Among people with formal education, 25% of post-graduates perceived the air quality to be very poor as against only 7% without formal education. Majority of the slum population do not perceive outdoor air pollution to be a problem at all and only considers smoke emitting sources which are visible through naked eyes as major pollution sources.

Lastly, several social studies in developing regions have shown that Sociodemographic factors such as age, gender, education, and health status have been found to be correlated with perceptions of air quality (Oltra & Sala, 2014,Guo et al. 2016). This clearly shows that perception of air quality is strongly linked to basic education on what makes air quality poor and hence it can be an important policy instrument for policy makers to focus into while drafting awareness measures for air pollution mitigation.

WAY FORWARD

Policy Recommendations

Policy Recommendations and Way Forward

Globally, ambient air pollution accounts for an estimated 0·98 million deaths in 2019 due to stroke, heart disease, lung cancer and chronic respiratory diseases (Lancet ICMR, 2020). As per WHO and ICMR, the vulnerable are young below 14 years of age and ederly above 50 years of age as they can easily develop respiratory health problems as compared to people of other age groups. This has been very clearly projected through the study. Hence, they need to be protected and sensitised. The actual impact of air pollution on health presented in this study is a conservative figure. Life threatening ailments like heart attacks, stroke, cancer etc. and other associated ailments like skin ailments, neurobehavioural and miscellaneous diseases, women's menstrual health, premature birth or low birth weight etc. have not been included in this assessment, because the evidence was not considered to be sufficiently robust. Administrative policies towards building a safe environment and breathing space are essential for maintaining the health integrity of the citizens. Towards this end, the state will function as a nodal agency to publicize the matter, build general awareness and issue health advisories from time to time to better tackle the issue. Both the policies framed and implemented by the public need strict action. The below recommendations can be considered while framing policies on maintaining a safe and healthy environment for the public for a post COVID-19 green recovery.

Address and improve air quality as per NCAP's target

Poor immunity, lack of access to nutrition and exposure to a mix of indoor and outdoor air pollutants caused from a multitude of factors like place of residence, lifestyle practices and occupations can manifest increased risks to ailments caused by poor air quality. It is therefore critical to start identifying it as a major health problem and develop immediate mitigation measures with stringent pressures created across all social, environmental, economic and political systems.

Switch to sustainable transport

The study uncovered that vehicular emissions, particularly in Kolkata have manifold implications on human health being the largest source of PM 2.5 pollution in the city. This calls for immediate switch to cycles, non-motorised transport and electric vehicles. Several Indian cities have already tested and piloted advanced mobility interventions which could be replicated for Bengal.

Increase public awareness on air pollution

It is critical to safeguard our children as the 'future of our planet' are at a higher risk of developing compromised lung capacities which can translate into dire consequences on human capital and regional economies. Better precautionary measures should be targeted for the elderly. Education and knowledge dissemination on air pollution should make their way across all socioeconomic levels. Campaigning activities, knowledge dissemination on daily air quality through media etc. must be considered to improve public awareness of the issue.

Introduce preventive health care interventions

Our health systems have already been pressurised and stretched beyond its limits due to the ongoing COVID-19 pandemic. It is frightening to think while we can isolate and vaccinate ourselves from contracting COVID-19, there is no vaccination or remedy per se for air pollution. Polluted air can also penetrate indoor environments and silently pose a serious health threat. There is an immediate need to devise tailored health protection schemes across all socioeconomic backgrounds

References

- M. Pascal, M. Corso, O. Chanel, C. Declercq, C. Badaloni, G. Cesaroni, S. Henschel, K. Meister, D. Haluza, P. Martin-Olmedo, S. Medina, Assessing the public health impacts of urban air pollution in 25 European cities: Results of the Aphekom project, Science of The Total Environment, Volume 449, 2013, Pages 390-400, ISSN 0048-9697

- Maji, K.J., Dikshit, A.K. and Deshpande, A. (2017). Assessment of City Level Human Health Impact and Corresponding Monetary Cost Burden due to Air Pollution in India Taking Agra as a Model City. Aerosol Air Qual. Res. 17: 831-842. https://doi.org/10.4209/aaqr.2016.02.0067

- Alberini, A., Cropper, M., Simon, N.B. and Sharma, P.K. (1997). The Health Effects of Air Pollution in Delhi, India, Policy Research Working Papers. The World Bank, Washington DC

- Averett, N. (2015). Exercising in polluted areas: The study suggests benefits outweigh the health risks of NO2 exposure. Environ. Health Perspect. 123: A158.

- Barrett, J.R. (2015). “Exported” deaths and short-term PM10 exposure: Factoring the impact of commuting into mortality estimates. Environ. Health Perspect. 123: A22.

- Brunekreef, B. and Holgate, S.T. (2002). Air pollution and health. Lancet 360: 1233–1242.

- Brunekreef, B. (2010). Air pollution and human health: From local to global issues. Procedia Soc. Behav. Sci. 2: 6661–6669.

- Hardoy J E, Mitlin D, Satterthwaite D, 2001 Environmental Problems in an Urbanizing World (Earthscan, London)

- Dasgupta P, 2004, ` `Valuing health damages from water pollution in urban Delhi, India: a health
- production function approach'' Environment and Development Economics 9 83 ^ 106

- Ramírez, A. S., Ramondt, S., Van Bogart, K., & Perez-Zuniga, R. (2019). Public Awareness of Air Pollution and Health Threats: Challenges and Opportunities for Communication Strategies To Improve Environmental Health Literacy. Journal of health communication, 24(1), 75–83. https://doi.org/10.1080/10810730.2019.1574320

- WHO. Effects of Air Pollution on Children's Health and Development: A Review of the Evidence. World Health Organization, Special Programme on the Health and Environment, European Centre for Environment and Health, Bonn Office; 2005.

- Lakshmi PV, Virdi NK, Sharma A, Tripathy JP, Smith KR, Bates MN, et al. Household air pollution and stillbirths in India: Analysis of the DLHS-II National Survey. Environ Res 2013;121:17-22.

- Egondi, T., Kyobutungi, C., Ng, N., Muindi, K., Oti, S., van de Vijver, S., Ettarh, R., & Rocklöv, J. (2013). Community perceptions of air pollution and related health risks in Nairobi slums. International journal of environmental research and public health, 10(10), 4851–4868. https://doi.org/10.3390/ijerph10104851

- Chattopadhyay, B.P., Mukherjee, A., Mukherjee, K. et al. Exposure to Vehicular Pollution and Assessment of Respiratory Function in Urban Inhabitants. Lung 185, 263–270 (2007). https://doi.org/10.1007/s00408-007-9015-0

- Baccarelli A., Martinelli I., Pegoraro V., Melly S., Grillo P., Zanobetti A., Hou L., Bertazzi P., Mannucci P., Schwartz J. Living Near Major Traffic Roads and Risk of Deep Vein Thrombosis. Circulation. 2009;119:3118–3124. doi: 10.1161/CIRCULATIONAHA.108.836163.

- Hoek G., Brunekreef B., Goldbohm S., Fischer P., Brandt P.A.V.D. Association between mortality and indicators of traffic-related air pollution in the Netherlands: A cohort study. *Lancet.* 2002;**360**:1203–1209. doi: 10.1016/S0140-6736(02)11280-3

- Hitchins J., Morawska L., Wolff R., Gilbert D. Concentrations of submicrometre particles from vehicle emissions near a major road. Atmos. Environ. 2000;34:51–59. doi: 10.1016/S1352-2310(99)00304-0.

- Zhang, K., & Batterman, S. (2013). Air pollution and health risks due to vehicle traffic. The Science of the total environment, 450-451, 307–316. https://doi.org/10.1016/j.scitotenv.2013.01.074

- Seán Schmitz, Laura Weiand, Sophia Becker, Norman Niehoff, Frank Schwartzbach, Erika von Schneidemesser,
- An assessment of perceptions of air quality surrounding the implementation of a traffic-reduction measure in a local urban environment,Sustainable Cities and Society, Volume 41, 2018, Pages 525-537, ISSN 2210-6707

- Pesola, G. R., & Ahsan, H. (2016). Dyspnea as an independent predictor of mortality. The clinical respiratory journal, 10(2), 142–152. https://doi.org/10.1111/crj.12191

- Goyal, R., Khare, M. Indoor air quality modeling for PM10, PM2.5, and PM1.0 in naturally ventilated classrooms of an urban Indian school building. Environ Monit Assess 176, 501–516 (2011). https://doi.org/10.1007/s10661-010-1600-7

- Muindi, K., Egondi, T., Kimani-Murage, E. et al. “We are used to this”: a qualitative assessment of the perceptions of and attitudes towards air pollution amongst slum residents in Nairobi. BMC Public Health 14, 226 (2014). https://doi.org/10.1186/1471-2458-14-226

- Sandberg J, Engström G, Ekström M (2019) Breathlessness and incidence of COPD, cardiac events and all-cause mortality: A 44-year follow-up from middle age throughout life. PLOS ONE 14(3): e0214083. https://doi.org/10.1371/journal.pone.0214083

- Saksena, S., Singh, P., Prasad, R. et al. Exposure of infants to outdoor and indoor air pollution in low-income urban areas — a case study of Delhi. J Expo Sci Environ Epidemiol 13, 219–230 (2003). https://doi.org/10.1038/sj.jea.7500273

- Anna Goodman, Paul Wilkinson, Mai Stafford, Cathryn Tonne,Characterising socio-economic inequalities in exposure to air pollution: A comparison of socio-economic markers and scales of measurement, Health & Place, Volume 17, Issue 3, 2011, Pages 767-774, ISSN 1353-8292, https://doi.org/10.1016/j.healthplace.2011.02.002.

- Yang, Z., Wang, Z., Yuan, XC. et al. Does income inequality aggravate the impacts of air pollution on physical health? Evidence from China. Environ Dev Sustain (2021). https://doi.org/10.1007/s10668-021-01522-w

- Lipfert, F. W. (2004). Air pollution and poverty: Does the sword cut both ways? Journal of Epidemiology and Community Health, 58(1), 2–3.

Annexure I

This section gives the data tables used in the study for reference purpose the visual presentation of which have been used in the chapters.

Table 1: % of people experiencing respiratory health problems during the Feb-Apr, 2021 study period across age groups			
Age group	**Sore throat**	**Sinus**	**Nasal Congestion**
<10 years old	23	22.1	23
10-18 years old	15	15	16
19-30 years old	15	13	17
31-50 years old	18	19	19
> 50 years old	29	23	29
*data based on people who do not smoke or are not exposed to smoking within the family			

Table 2: % of people experiencing respiratory health problems during the Feb-Apr, 2021 study period across age groups		
Age group	**Sneezing**	**Cough**
<10 years old	55%	47%
10-18 years old	35%	30%
19-30 years old	26%	23%
31-50 years old	33%	30%
> 50 years old	43%	41%

Table 3: % of people experiencing respiratory health problems during the Feb-Apr, 2021 study period across age groups							
Breathlessness at rest - less than 50 years of age	**Breathlessness at rest - More than 50 years of age**	**Breathlessness while walking-less than 50 years of age**	**Breathlessness while walking-More than 50 years of age**	**Breathlessness while climbing-less than 50 years of age**	**Breathlessness while climbing-More than 50 years of age**	**Chest discomfort/ chest tightening-less than 50 years of age**	**Chest discomfort/ chest tightening -More than 50 years of age**
7%	35%	11%	44%	22%	53%	8%	19%

Table 4: % of people experiencing respiratory health problems during the Feb-Apr, 2021 study period across income groups				
income group	**Sore throat**	**Sinus**	**Nasal Congestion**	**Eye irritation**
Up to 5k	24%	24%	26%	27%
5k-10k	15%	14%	14%	20%
10k-25k	8%	12%	18%	23%
25k-50k	4%	7%	18%	16%
*data based on people who do not smoke or are not exposed to smoking within the family				

Annexure II

Table 5: % of people experiencing respiratory health problems during the Feb-Apr, 2021 study period across income groups		
Income groups	**Sneezing**	**Cough**
Up to 5k	54%	49%
5k-10k	20%	19%
10k-25k	25%	20%
25k-50k	29%	26%

Table 6: % of people at different occupation groups and their perception of outdoor air quality		
Outdoor Air quality	**Construction/ Industrial workers**	**Drivers**
Very Poor	10	19
Poor	53	69
Good	37	12
Very Good	1	0

Table 7: % of people at different education levels and their perception of outdoor air quality		
Outdoor Air quality	**No formal education**	**With formal education**
Very Poor	7%	19%
Poor	34%	60%
Good	59%	21.00%
Very Good	0%	1%

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