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Estimating the Cost-of-Illness due to Air Pollution – A Case Study of Kolkata

Soham Mitra
Researcher, Department of Economics, The University of Burdwan, Bardhaman, West Bengal, India

Chirodip Majumdar
Associate Professor, Department of Economics, Rabindra Mahavidyalaya, Champadanga, Hooghly, 712401, West Bengal, India

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ABSTRACT

Mortality and morbidity loss due to air pollution are huge in Kolkata. The use of solid fuels in industries and a steep rise in the number of vehicles are the two major causes of air pollution in Kolkata. The level of suspended particulate matter (SPM) in the air in Kolkata is far above the safe limit. The result is the incidence of airborne diseases. The present study gathers information from 312 households in Kolkata about the incidence of airborne illness. The main objective of the present study is to estimate the "cost of illness" due to air pollution in the case of Kolkata. The health cost estimation study can give an idea about the "out-of-pocket" medical treatment cost as well as the "opportunity cost of lost time" due to air pollution-related illness. The present study found a significant monetary burden due to airborne diseases in Kolkata.

Keywords: *Airborne diseases, Cost-of-Illness, Opportunity Cost, PM*

1. Introduction

2. The direct correlation between air quality and health, particularly concerning airborne illnesses, underscores the critical importance of clean air for human well-being. However, urbanization has led to a decline in ambient air quality, resulting in a variety of respiratory diseases caused by air pollution. Polluted air significantly impacts human health, ranging from minor ailments like coughs and colds to more severe conditions such as bronchitis, pharyngitis, pneumonia, and asthma (Park, 2000). Numerous studies (such as Chappie and Lave, 1982; Villeneuve et al. 2003; Jarrett et al., 2004) worldwide have demonstrated a clear connection between air pollution and increased mortality rates. Additionally, the morbidity burden is substantial, primarily manifesting as respiratory infections. Anon. (1997) estimated that reducing pollution levels in Kolkata to World Health Organization (WHO) standards could prevent over 10,647 pollution-related premature deaths annually. A study by Lahiri et al. (2002) compared the prevalence of respiratory symptoms among individuals in Kolkata and rural areas with

lower pollution levels, revealing significantly higher rates of respiratory issues in urban areas, particularly among smokers. Respiratory problems worsen during winter months and are more prevalent among those exposed to vehicular emissions. Cough and cold are the most commonly reported symptoms among affected individuals.

3. The present study is an attempt to estimate health costs due to air pollution in Kolkata. It uses cost of illness (COI) methods to estimate the healthcare costs due to airborne diseases. The information is gathered from a sample survey of 312 households in Kolkata. Section – 2 of the paper reports the results of some COI studies performed in India. Section – 3 describes the COI methodology. Section – 4 describes the sampling frame and procedure. Section – 5 reports the sample characteristics. Section – 6 describes the summary of the illness data. Section – 7 estimates the cost of treatment. Section – 8 concludes by discussing that there is enough scope to mobilise resources from citizens to implement an air quality improvement programme.

4. 2. A Short Review of Cost of Illness Studies Due to Air Pollution in India

5. There is a limited number of studies in India that aim to evaluate the impact of air pollution. Cropper et al. (1997) is a notable attempt to assess the influence of SPM on daily deaths in Delhi from 1991 to 1994. The research employed a time series analysis of daily observations of death rates and pollution levels to understand the repercussions of air pollution. Comparing the Delhi results with similar studies in the US, the study identified differences in the distribution of deaths by age and cause. Unlike the US, where individuals over 65 years are most susceptible, in Delhi, those aged 15 to 44 years face higher vulnerability, resulting in a greater loss of life years.
6. Lvovsky (1998) conducted an assessment of the impact of air pollution on mortality in several Indian cities. The findings indicated a significant health burden when compared internationally. The study estimated the total annual health damages from the combustion of various fuels, including those used by vehicles, industries, and households, amounting to $150 million at 1992 prices.
7. In another study, Kumar and Rao (2001) focused on estimating the dose-response function (DRF) to establish a link between environmental variables and observable health effects. The research, centered around the Panipat thermal power station, revealed that households in the vicinity of the power station bear a substantial opportunity cost of illness.

8. Lahiri et al. (2002) conducted a comparison of the prevalence of respiratory symptoms, such as breathing difficulties, between individuals living in Kolkata and those residing in non-polluted rural areas of the state. The study found that while 45 percent of rural individuals reported such issues, the percentage rose to 75 percent among urban households in Kolkata. Additionally, 83 percent of smokers in Kolkata experienced respiratory problems, and these issues were exacerbated during winter months. Those exposed to vehicular emissions exhibited a higher incidence of respiratory troubles, with cough and cold being the most common symptoms reported by individuals.
9. Murty et al. (2003) conducted a comparison of household data from Delhi and Kolkata, estimating that the average annual benefit to a household for reducing SPM from current levels to the safe level is Rs. 2086 and Rs. 950, respectively. The study employed the Household Production Function (HPF) approach, calculating total benefits through a combination of averting and mitigating activities.
10. In a separate study, Gupta (2006) gathered weekly health data across three seasons from households in Kanpur to assess the health costs associated with air pollution. The health cost was determined by measuring the loss in wages due to missed workdays and the expenses incurred on medical goods and services. The findings suggested that households in Kanpur could gain an average of Rs. 165 per year if air pollution were reduced to a safe level.
11. Examining 347 households around seven pollution monitoring stations in Delhi, Kathuria and Khan (2007) discovered that the most affected by air pollution were poorer households, those belonging to backward castes, and households with fewer years of education. Conversely, richer households were found to be the least affected by air pollution.
12. Ghosh et al. (2005) investigated the impact of vehicular emissions on urban air quality and public health in Kolkata, India. It highlighted the contribution of motor vehicles to air pollution, particularly the emission of CO, O_3, and particulate matter, and emphasised the association of PM_{10} with morbidity. The study assesses the status of air pollution in Kolkata, monitoring ambient air quality and micrometeorological data. The study revealed that elevated levels of pollutants, surpassing the permissible limits, result from vehicle emissions, industrial pollutants, and the use of solid fuels. The study explores the influence of air pollution on human health, particularly respiratory issues, and suggests a comprehensive air quality management strategy to alleviate urban air pollution by controlling emissions from industries and vehicles, encouraging the use of

cleaner fuels, and improving traffic management. The findings offer insight into the urgent need for implementing effective measures to address urban air pollution and its impact on public health in developing countries.

13. A study by Majumdar (2010) found that air pollution in Kolkata is a major cause of mortality and morbidity loss. The study involved 600 households and found that vulnerable people with chronic illnesses, smoking habits, and minority communities are more affected. The study found that citizens bear a significant health cost due to airborne diseases. The pollution levels in Kolkata are far above the safe limit, leading to respiratory diseases such as bronchitis, pharyngitis, pneumonia, and asthma. The study also found that 83% of smokers in Kolkata suffer from respiratory problems, aggravated during winter months.

14. Haque and Singh (2017) assessed the health status of 100 individuals in Kolkata using a survey and showed that respondents with respiratory diseases (85.1%) have outnumbered waterborne diseases (14.9%). These respiratory diseases include acute respiratory infections (ARI) (60%), chronic obstructive pulmonary diseases (COPD) (7.8%), upper track respiratory infection (UTRI) (1.2%), Influenza (12.7%), and acid-fast bacillus (AFB) (3.4%).

15.3. Cost of Illness

16. COI method stands as one of the earliest economic evaluations in the healthcare sector. Its primary goal was to assess the overall economic impact of illness on society, encompassing medical resource consumption and productivity losses. This method operates on the assumption that the COI represents the potential benefits of healthcare interventions capable of eliminating said illnesses. COIs are among the most common economic studies in the healthcare sector and are used by the World Bank, WHO, and the US National Institute of Health.

17.3.1. Types of Costs in COI Studies

18. A comprehensive COI study includes both direct and indirect costs. Direct costs measure the opportunity cost of resources used for treating a particular illness, whereas indirect costs measure the value of resources lost due to a particular illness. Opportunity cost, in this case, is defined as the value of the forgone opportunity to use differently those resources that are used or lost due to illness (Hodgson and Meiners, 1982). Although some studies also include intangible costs of pain and suffering, usually in the form of quality-of-life measures, this category of costs is often omitted because of the difficulty in accurately quantifying it in monetary terms.

19.3.1.1. Direct Costs

20. Studies commonly measure total direct costs, which represent the expenses of resources used. Direct medical costs encompass various expenses such as hospital stays, physician visits, emergency room visits, nursing home care, rehabilitation care, and prescription drugs (Rice, 1995).

21. Non-medical direct costs encompass expenses such as transportation fees for healthcare visits, reallocation costs, and expenses associated with modifying one's diet, home, vehicle, or related items. However, certain nonmedical costs like research or capital expenses are usually excluded from COI studies due to challenges in attribution.

22.3.1.2. Indirect Costs

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24. Productivity costs quantify the economic impact of illness and death on production, rooted in the human capital approach (HCA). While the HCA's foundations date back to the 17th century, its significant development occurred in the early 1960s. The HCA substantially developed with growing recognition of the importance of human resources in the US economy (Denison, 1980). Mushkin (1962) stands out as a pivotal work applying the HCA to assess growth potential in the healthcare sector.

25. Mushkin proposes using earnings as a measure of labor productivity, as wages reflect the value of the contribution of an individual to production. In early COI studies, morbidity costs were calculated by applying average earnings based on age and gender to the time spent away from work (Rice, 1966). Mortality costs, on the other hand, assess the loss of production due to premature death.

26. Adjustments were also considered for individuals not actively participating in the labour market, particularly focusing on valuing the services provided by housewives (Brody, 1975; Rice, 1966). These services were estimated by their potential market value through the replacement value method. Another approach assumes that the economic worth of unpaid work is equivalent to the wage rate the individual could earn in the job market. This is known as the opportunity cost method. In essence, if a woman opts for housework instead of employment, the value of the housework should be at least as much as the value of employment (Gronau, 1973; Murphy, 1978).

27.4. Sampling Procedure

28. Kolkata is mostly affected by PM_{10}, as expected in a megacity, which adversely affects the health of its citizens (Spiroska et al. 2011). Monitoring of air quality parameters is continuously done in 19 locations in Kolkata by the Central Pollution Control Board

(CPCB). These 19 stations can be classified into three zones. According to the 4-year PM_{10} concentration, Moulali, Dunlop, Hyde Road, Shyambazar, Topsia, and Ultadanga can be classified as high pollution zones, whereas, Salt Lake, Baishnabghata, Dalhousie, Kasba, Tollygunge, Mominpur, Picnic Garden, and Rajarhat belong to low pollution zones. Minto Park, Behala, Cossipore, Gariahat, and Beliaghata are moderate pollution zones. Using a lottery procedure, the present study selects 2 locations from each category randomly. Therefore, 6 locations are randomly selected from 19 locations. The 6 selected locations are Shyambazar and Dunlop (from high pollution zone); Behala and Gariahat (from moderate pollution zone); and Salt Lake and Tollygunge (from low pollution zone). 52 household samples are collected randomly from each of these 6 locations. Hence the present study used a total of 312 samples from all over Kolkata. Households were taken around the monitoring stations as dispersion of pollutants and hence exposure may not be far-reaching. It is assumed that each individual is exposed equally around a pollution monitoring station.

29. Quantitative and qualitative data have been collected through a questionnaire. The questionnaire was written in Bengali to make it easier for responders to grasp. Three drafts version of the questionnaire were pretested by surveying five respondents at each location. The pretest was performed with great caution to improve the ordering of questions, the language of the questionnaire, etc. The pretest was effective in various matters, especially in selecting the income categories. The surveyor collected the data by direct interview method during the months of August to October 2021. This was the period just after the second wave of the COVID-19 pandemic. Proper precautions and safety measures were taken to pursue the survey.

30. Information was obtained from the head of the household as far as possible otherwise the available member was asked to answer the questions. The respondent was allowed to make changes in answers that she felt necessary at any stage of the survey. The respondent was permitted to consult other members of the household or anyone else while replying. Surveyor first stated some facts with data regarding the condition of air quality in Kolkata and the burden of diseases due to air pollution. This introduction made the scenario more believable and helped the respondents to relate to the problem. The sequencing of the questions was done properly. Movement from one section to another was smooth. The description of the topics was kept in between questions to retain the respondent's attention. Questions about the respondents' characteristics were set at the end of the questionnaire.

31.5. Sample Characteristics

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33. The descriptive statistics for the survey are summarised below. Information was obtained from the head of the household as far as possible. The actual number of respondents' gender is shown in Table – 1. Percentages are shown in parentheses[1]. In this study, the female respondents were almost 50 percent of the total samples.

Table – 1: Sample description of respondent's gender

Location	Male	Female	Total
Shyambazar	27 (51.92)	25 (48.08)	52
Behala	29 (55.77)	23 (44.23)	52
Dunlop	24 (46.15)	28 (53.85)	52
Gariahat	22 (42.31)	30 (57.69)	52
Tollygunge	30 (57.69)	22 (42.31)	52
Saltlake	25 (48.08)	27 (51.92)	52
Total	157 (50.32)	155 (49.67)	312

34. The present study obtained responses from more than 90 percent of Hindus. The actual numbers and percentages (in parentheses) are shown in Table – 2.

Table – 2: Sample description of respondent's religion

Location	Hindu	Muslim	Total
Shyambazar	48 (92.31)	4 (7.69)	52
Behala	46 (88.46)	6 (11.54)	52
Dunlop	47 (90.38)	5 (9.62)	52
Gariahat	50 (96.15)	2 (3.85)	52
Tollygunge	48 (92.31)	4 (7.69)	52
Saltlake	49 (94.23)	3 (5.77)	52
Total	288 (92.30)	24 (7.7)	312

35. A project of the World Bank in 2001 on WTP in Kolkata obtained that the average family size in Kolkata is approximately 5. According to the census (2011) mean

[1] Percentages in each table represent the proportion of a category in one location. For instance, in Table – 1, $(\frac{27}{52}\times 100) = 51.92$ percent represents the proportion of the male population in Shyambazar.

household size for KMC is 4.4. The present study found the average household size as 3.85 and the number of three and four-member families are highest in the present sample (Table – 3). Shyambazar and Behala showed a significant number of large families.

Table – 3: Sample description of respondent's number of family members

Location	One	Two	Three	Four	Five	Six	Seven	Eight
Shyambazar	0	3 (5.77)	19 (36.54)	12 (23.08)	8 (15.38)	5 (9.62)	3 (5.77)	2 (3.85)
Behala	0	3 (5.77)	8 (15.38)	29 (55.77)	6 (11.54)	5 (9.62)	0	1 (1.92)
Dunlop	0	5 (9.62)	19 (36.54)	15 (28.85)	7 (13.46)	6 (11.54)	0	0
Gariahat	1 (1.92)	6 (11.53)	19 (36.54)	15 (28.85)	9 (17.30)	1 (1.92)	1 (1.92)	0
Tollygunge	0	1 (1.92)	15 (28.85)	23 (44.23)	7 (13.46)	5 (9.62)	1 (1.92)	0
Saltlake	0	8 (15.38)	23 (44.23)	17 (32.69)	3 (5.77)	1 (1.92)	0	0
Total	1 (0.32)	26 (8.33)	103 (33.01)	111 (35.57)	40 (12.82)	23 (7.37)	5 (1.60)	3 (0.96)

36. Nearly 27 percent of households interviewed reported the presence of children below 5 years of age in their household. Maximum households have one child in their family. The actual data regarding the number of children are summarised in Table – 4. Percentages are shown in parentheses.

Table – 4: Sample description of respondent's number of children

Location	Zero	One	Two	Three	Total
Shyambazar	32 (61.53)	14 (26.92)	4 (7.69)	2 (3.84)	52
Behala	37 (71.15)	11 (21.15)	3 (5.76)	1 (1.92)	52
Dunlop	37 (71.15)	13 (25)	2 (3.85)	0	52
Gariahat	39 (75)	10 (19.23)	2 (3.85)	1 (1.92)	52
Tollygunge	40 (76.92)	9 (17.30)	3 (5.76)	0	52
Saltlake	42 (80.76)	10 (19.23)	0	0	52
Total	227 (72.75)	67 (21.47)	14 (4.48)	4 (1.28)	312 (100)

37. The present study found that around 18% of respondents are unemployed. Almost 20% of the sample population was found to be self-employed and the contribution of small businesses led by females is significant in this category. The data regarding occupational structure is summarised in Table – 5. Percentages are shown in parentheses.

Table – 5: Sample description of respondent's occupation

Location	Employed (Govt. + Private)	Self – Employed + Business	Retired + Housewife + Student	Unemployed	Total
Shyambazar	17 (32.69)	7 (13.46)	15 (28.85)	13 (25)	52
Behala	21 (40.38)	9 (17.31)	14 (26.92)	8 (15.38)	52
Dunlop	16 (30.77)	12 (23.08)	19 (36.54)	5 (9.62)	52
Gariahat	13 (25)	11 (21.15)	13 (25)	15 (28.85)	52
Tollygunge	14 (26.92)	10 (19.23)	21 (40.38)	7 (13.46)	52
Saltlake	15 (28.85)	11 (21.15)	16 (30.77)	10 (19.23)	52
Total	96 (30.76)	60 (19.23)	98 (31.41)	58 (18.58)	312

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49. According to the Census (2011), almost 20 percent of the total population of Kolkata have a graduate degree or post-graduate degree. 11 percent of the population of Kolkata have a secondary degree and 10 percent of them have a higher secondary degree. The present study also found that 11 percent of the sample individuals have a secondary degree. However, 55 percent of the respondents were found to be graduates or post-

Table - 6: Sample description of respondent's educational qualification

Educational Qualification	Shyambazar	Behala	Dunlop	Gariahat	Tollygunge	Saltlake	Total
Literate	0	1 (1.92)	0	0	0	0	1 (0.32)
Class 4 or less	1 (1.92)	0	0	0	0	1 (1.92)	2 (0.64)
Class 5 to 8	0	3 (5.77)	7 (13.46)	1 (1.92)	8 (15.38)	2 (3.85)	21 (6.73)
Below Madhyamik	2 (3.85)	0	3 (5.77)	2 (3.85)	4 (7.69)	1 (1.92)	12 (3.84)
Madhyamik	4 (7.69)	6 (11.54)	9 (17.31)	7 (13.46)	6 (11.54)	2 (3.85)	34 (10.89)
Below Higher Secondary	1 (1.92)	0	0	1 (1.92)	0	0	2 (0.64)
Higher Secondary	8 (15.38)	16 (30.77)	13 (25)	11 (21.15)	10 (19.23)	11 (21.15)	69 (22.11)
Graduation	25 (48.08)	19 (36.54)	15 (28.85)	21 (40.38)	14 (26.92)	26 (50)	120 (38.46)
Post-Graduation	11 (21.15)	7 (13.46)	5 (9.62)	9 (17.31)	10 (19.23)	9 (17.31)	51 (16.34)
Total	52	52	52	52	52	52	312

Table - 7: Sample description of respondent's age group

Age Group	Shyambazar	Behala	Dunlop	Gariahat	Tollygunge	Saltlake	Total

graduates. The data regarding the respondent's educational qualification is summarised in Table – 6. Percentages are shown in parentheses.

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59. The present study has collected the maximum sample from the age group of 25 to 45, i.e. the working group who faced air pollution most in their daily life. The data regarding the respondent's age is summarised in Table – 7.

60. The present study found Rs. 27,992 as the mean monthly income and 18,973 as the standard deviation of the monthly income. The data regarding the monthly family income is summarised in the following table (Table – 8).

Table – 8: Sample description of respondent's monthly family income

Income Categories	Frequency	Income Categories	Frequency
Below 5000	16	40001-45000	18
5000-10000	42	45001-50000	9
10001-15000	42	50001-55000	4
15001-20000	43	55001-60000	15
20001-25000	25	60001-65000	5
25001-30000	33	65001-70000	4
30001-35000	14	70001-75000	1
35001-40000	27	More than 75000	15

61.6. Data Regarding the Illness Due to Air Pollution

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63. Investigating the location-specific incidence of illness is a crucial aspect of this study. A survey was conducted in six different areas in Kolkata, selected to ensure that samples could be obtained around the operational air quality monitoring stations in the city. The summary of disease incidence in 6 locations is presented in Table – 9. Percentages are shown in parentheses.

Table – 9: Incidence of illness due to air pollution in the last year

Location	Number of households affected due to airborne diseases	Number of households affected more than one time due to airborne diseases	Number of persons affected due to airborne diseases	Number of persons affected more than one time due to airborne diseases
Shyambazar	20 (38.46)	7 (13.46)	24 (11.00)	5 (2.29)
Dunlop	22 (42.30)	5 (9.61)	23 (11.61)	4 (2.02)
Gariahat	21 (40.38)	4 (7.69)	25 (13.29)	2 (1.06)
Behala	18 (34.61)	5 (9.61)	22 (10.28)	3 (1.40)
Tollygunge	17 (32.69)	2 (3.84)	19 (9.00)	2 (0.94)
Salt lake	15 (28.84)	2 (3.84)	15 (8.62)	2 (0.94)
Overall	113 (36.21)	25 (8.01)	128 (10.64)	18 (1.49)

64. In this survey, respondents were sensitized about the symptoms associated with prevalent airborne respiratory illnesses. The survey questionnaire was carefully crafted to collect information regarding the occurrence of common respiratory ailments such as ordinary cough and cold, bronchitis, pharyngitis, pneumonia, COPD, and asthma within households over the past year. Table – 9 indicates that, among the total 312 households that were surveyed, 113 households reported being affected by airborne diseases in the last year. That means more than one-third of the households reported experiencing airborne diseases outlined in the questionnaire during the preceding year. It is very much possible that multiple members of a single household were affected due to airborne diseases, even an individual can be affected several times in the last year. The questionnaire was suitably designed and the surveyors were instructed to identify such cases. To capture this burden of diseases, the survey asked each household about how many times and how many members in the household were affected in the last year. Among 113 households that reported airborne diseases, 25 households were affected multiple times by airborne diseases in the last year.

65. In the present study, 312 households were surveyed and those households have 1203 individuals in total. Among these 1203 individuals, 128 individuals (10.64%) were attacked by airborne diseases (Table – 9). Among those 128 affected individuals, 18 individuals were attacked by airborne diseases multiple times in the last year. The survey also asked about the presence of chronic airborne diseases (such as dust allergy,

asthma, COPD, etc.) in the household. 66 out of 312 households (21.15%) reported the presence of chronic airborne diseases in their households.

66. Airborne illnesses are caused by pathogens, such as bacteria, viruses, or fungi that are transmitted through the air. These diseases are often spread through respiratory droplets, which can be released into the air when an infected person talks, coughs, or sneezes. Common airborne diseases include common headaches, coughs and colds, dust allergies, etc. Table – 10 shows the distribution of different types of airborne diseases in the sample. These diseases can be caused by other factors also, but air pollution is one of the major factors behind these diseases.

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Table – 10: Location-wise distribution of airborne diseases

Location	Shyambazar	Dunlop	Gariahat	Behala	Tollygunge	Salt lake	Total
Headache	3	2	4	4	5	4	22
Eyes, Nose, Throat Irritation	1	0	2	1	4	0	8
Skin Infection and Rashes	4	3	2	2	3	2	16
Sneeze, Runny Nose	0	1	2	0	2	1	6
Dust Allergy	5	6	5	4	3	2	25
Dry Cough	5	4	5	6	3	1	24
Respiratory Problem	4	3	3	2	1	3	16
Asthma	4	3	4	2	2	4	19
COPD	3	4	1	0	1	3	12
Coronary Artery Disease	2	1	2	1	2	3	11
Lung Cancer	0	1	0	0	0	0	1
All Diseases	31	28	30	22	26	23	160

69.7. Cost of Illness Due to Airborne Diseases

70. Analysts commonly establish values for illness, disease, and healthcare services by attributing monetary values to cost components. These costs are divided into direct and indirect measures. Direct costs encompass medical care expenses, including self-medication, clinic visits, prescribed medicines, and diagnostic tests, along with transportation and household expenses, known as "out-of-pocket" costs. Indirect costs stem from productivity loss, including time spent seeking medical care and missed work

days. Economists refer to the monetary value of indirect costs as the opportunity cost of lost time.

71. Using the survey questionnaire, the current study gathered data on the medical care sought and estimated the associated costs for individuals who experienced illness. Participants were queried about their symptoms and the actions taken to alleviate them.

72.7.1. Estimating Out-of-Pocket Cost of Medical Treatment

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74. Out-of-pocket costs refer to the total monetary expenditure by the households due to airborne diseases. Out-of-pocket costs can be divided into two categories – i) expenditure due to non-prescription medications or self-medications and ii) expenditure due to treatments advised by the doctor.

75.7.1.1. Estimating the Expenditure of Non-prescription Medications

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77. Non-prescription medicines, also commonly known as over-the-counter (OTC) medications, play a pivotal role in self-care and addressing minor health concerns without the need for a prescription. These medications are readily available to the public and are typically deemed safe for use without direct medical supervision. Table – 11 summarises the information regarding the use of non-prescription medicines by the households. Percentages are shown in parentheses.

78.

Table – 11: Use of non-prescription medicines by the households in the last year

Location	Number of households seeking non-prescribed medication	Maximum number in a household	Average number for all the households	Average number for households seeking non-prescribed medication
Shyambazar	8 (15.38)	3	0.35	2.25
Dunlop	10 (19.23)	5	0.38	2
Gariahat	7 (13.46)	3	0.23	1.71
Behala	8 (15.38)	2	0.29	1.87
Tollygunge	9 (17.30)	4	0.32	1.89
Salt lake	6 (11.53)	2	0.21	1.83
Overall	48 (15.38)	5	0.30	1.92

79.

80. Each household was asked to recall the average expenditure for non-prescription medicines they bought. The survey also asked for the number of times the non-prescription medicine was bought for a particular household. Information regarding non-prescription expenditure due to airborne diseases is shown in Table – 12. The average expenditure for non-prescription medicines is not very high. It came out as 41.98 rupees per year, per household.

Table – 12: Expenditures on non-prescription medicines in the last year

Location	Average expenditure for the non-prescription medicine for all the households	Average expenditure for non-prescription medicine for households seeking non-prescription medicine
Shyambazar	48.08	312.50
Dunlop	57.69	300
Gariahat	44.23	328.57
Behala	32.70	212.50
Tollygunge	42.31	244.45
Salt lake	26.92	233.34
Overall	41.98	271.89

81.

82.7.1.2. Estimating the Expenditure of Treatments Advised by Doctor

83. Apart from the use of non-prescription medicine, the second highest sought medical care service was found to be the service of a doctor. The expenditure of treatment advised by the doctor can be divided into five categories. A) fees of the doctors; B) expenditure for prescribed medications; C) expenditure for diagnostic examinations advised by the doctor; D) expenditure due to hospitalisation; and E) transportation costs seeking medical services.

84.7.1.2.1. Expenditure Due to Fees of the Doctor

85. The fees charged by doctors in Kolkata vary depending on factors such as the medical specialty, the experience of the practitioner, and the type of healthcare facility. In general, fees for a consultation with a doctor in Kolkata can range from affordable to relatively higher, especially for specialized services. The current study asked the respondents of each household about the number of members who had to visit the doctor's clinic, the number of visits to the doctor in the last year, the name of the disease, etc. The survey found that asthma patients, patients with other respiratory

problems, and COPD patients had visited the doctor's clinic most. Table – 13 summarises the information regarding the visit to the doctor's clinic in the last year.

Table – 13: Location-wise data regarding consultation of the doctor in the last year

Location	Number of households seeking the doctor's Service	Maximum number in a household	Average number for all the households	Average number for households seeking the doctor's service
Shyambazar	10 (19.23)	5	0.48	2.5
Dunlop	9 (17.30)	6	0.38	2.2
Gariahat	11 (21.15)	3	0.35	1.6
Behala	8 (15.38)	3	0.29	1.9
Tollygunge	6 (11.53)	2	0.19	1.7
Salt lake	7 (13.46)	2	0.29	2.1
Overall	51 (16.34)	6	0.33	2

86. Each household was asked to recall the fees of the doctor they visited. The survey also asked for the number of visits to the doctor for a particular household. Information regarding the expenditure due to fees of the doctor is shown in Table – 14. The average expenditure for the fees of the doctor of all the households in the last year is found to be 204.15 rupees.

Table – 14: Expenditure due to fees of the doctors in the last year

Location	Average expenditure for the fees of the doctor of all the households	Average expenditure for the fees of the doctor of households seeking doctor's service
Shyambazar	215.38	1120
Dunlop	230.76	1334.33
Gariahat	153.84	727.27
Behala	163.46	1062.50
Tollygunge	182.70	1583.53
Salt lake	278.85	2071.42
Overall	204.15	1316.50

87.7.1.2.2. Expenditure Due to Medications Advised by the Doctor

88. Expenditure due to medications advised by a doctor is a significant component of healthcare costs for individuals. Question regarding the number of times a particular prescription medicine was bought was not asked in the questionnaire but the average cost was asked for. The number was approximated by the number of visits to a doctor's clinic. Hence, the total expenditures due to prescribed medicines were calculated. Average expenditures of prescribed medicines were computed by dividing the total expenditure by 312. Information regarding the expenditures for prescribed medicines is shown in Table – 15. The average expenditure for the medicines prescribed by the doctor of all the households in the last year is found to be 340.06 rupees.

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Table – 15: Expenditure on prescribed medicines in the last year

Location	Average expenditure for the prescribed medicines of all the households	Average expenditure for the prescribed medicines of households seeking doctor's service
Shyambazar	384.62	2010
Dunlop	405.76	2344.45
Gariahat	367.31	1736.35
Behala	292.30	1900
Tollygunge	234.61	2033.35
Salt lake	355.76	2642.85
Overall	340.06	2111.26

92.7.1.2.3. Expenditure Due to Diagnostic Examination Advised by the Doctor

93. Expenditure incurred for diagnostic examinations recommended by doctors for airborne diseases contribute to the overall costs associated with healthcare. These costs often include expenses related to various diagnostic tests (X-rays, CT scans, and blood tests) and procedures deemed necessary for the identification, assessment, and treatment of diseases transmitted through the air. Each household was asked to recall the last year's total expenditures due to diagnostic examinations advised by the doctor.

It was found that overall 24 households among 51 households who took consultation of a doctor, sought various types of diagnostic examinations in the last year as advised by the doctors. 47.05 percent of households that had visited to doctor, sought diagnostic examinations. Out of 312 households that were surveyed, 7.69 percent sought diagnostic examinations. Table – 16 shows the average expenditures due to diagnostic examinations. The average expenditure for diagnostic examinations in the last year is found to be 79.12 rupees per household.

Table – 16: Expenditure for diagnostic examinations in the last year

Location	Average expenditure for the diagnostic examinations of all the households	Average expenditure for the diagnostic examinations of households seeking diagnostic examinations
Shyambazar	88.46	458.62
Dunlop	80.76	467.56
Gariahat	75.79	381.27
Behala	73.29	452.87
Tollygunge	73.07	632.85
Salt lake	83.35	542.85
Overall	79.12	489.34

94.7.1.2.4. Transportation Cost of Seeking Medical Services

95. The transportation cost of seeking medical services refers to the expenses incurred when traveling to and from healthcare facilities. This includes the money spent on various modes of transportation such as fuel for private vehicles, public transportation fees, or expenses related to taxis or rideshare services. The survey asked the average expenditure a particular household had to bear per visit and how many times that household had to visit. Some households reported zero transportation costs as the doctor's clinic or diagnostic center was within walking distance. However, households that reported hospitalization, had borne higher transportation costs due to charges of the ambulance. Out of 51 households seeking medical services, 45 households reported to bear transportation costs. The average transportation cost of households seeking medical services as shown in Table – 17, is found to be 124.93 rupees.

Table – 17: Transportation cost of seeking medical services in the last year

Location	Average transportation cost of all the Households	Average transportation cost of households seeking medical services
Shyambazar	36.76	186.79
Dunlop	39.53	210.56
Gariahat	28.65	177.86
Behala	23.75	88.67
Tollygunge	12.53	85.72
Salt lake	44.23	328.57
Overall	30.90	124.93

96.7.1.2.5. Expenditure Due to Hospitalisation

97. Expenditure due to hospitalisation constitutes a significant aspect of healthcare costs, encompassing various elements such as room charges, medical procedures, diagnostic tests, medications, and healthcare professional fees. Each household in this survey was asked whether any member of the household was hospitalised in the last year and if yes, then to recall the total amount of hospital bill. The survey also asked for the type of hospital and the number of days the patient was admitted in the hospital. Hospitalisation details are shown in Table – 18. As expected, the hospitalisation rate is low.

Table – 18: Total expenditure due to hospitalization

Location	Total Hospital Bill	Type of Hospital	Number of Days
Shyambazar	15,000	Public Hospital	15
	15,000	Private Hospital	7
Dunlop	12,000	Public Hospital	10
Gariahat	70,000	Private Hospital	20
Salt lake	35,000	Private Hospital	7
	75,000	Private Hospital	15

98. Overall, 6 households out of 312 households reported hospitalisation of their family members. Out of 113 households that were reported to be affected due to airborne diseases, only 5.30% of households reported hospitalisation. Location-wise information regarding the average expenditure of hospitalisation is shown in Table – 19.

Table – 19: Expenditure due to hospitalisation in the last year

Location	Average expenditure for the hospitalization of all the households	Average expenditure for the hospitalization of households seeking hospital service
Shyambazar	576.92	15,000
Dunlop	230.77	12,000
Gariahat	1057.70	55,000
Behala	0	0
Tollygunge	0	0
Salt lake	2115.38	55,000
Overall	663.46	22,833.33

99.7.2. Opportunity Cost of Lost Time Due to Illness

100. The economic impact of illness-related time loss, seen through opportunity cost, is complex and extends widely. While healthcare costs often dominate immediate concerns, the deeper economic impact lies in missed opportunities during recovery. Time spent recuperating could have been used for income generation, career growth, or skill development, each with its economic value. Opportunity cost highlights the finite nature of resources, emphasizing the need for careful allocation, especially in the workforce, where illness can lead to reduced productivity and hindered earning potential. These effects ripple through the economy, affecting overall productivity. Recognising and addressing this cost is crucial for individual and economic well-being. Estimating time loss involves considering both medical care time and time absent from market activities. Seeking medical care can be time-consuming, with inherent opportunity costs as time could be spent elsewhere.

101. The survey questionnaire was meticulously prepared to capture the comprehensive time lost due to the utilisation of medical goods and services. Though students, retired persons, homemakers, and unemployed individuals do not participate in market or job activities directly, the lost time of those categories was also recorded. The survey found cases when a particular patient from one household had sought medical services multiple times in the last year or several members of a particular household sought the service. A total of 51 households had visited a doctor or diagnostic center and members from these 51 households had sought medical services 107 times.

Table – 20: Average time spent seeking medical service (in hours)

Location	Maximum	Minimum	Average
Shyambazar	366.21	1	11.12
Dunlop	246.58	1	5.65
Gariahat	482.66	0.50	10.19
Behala	14.36	1	1.05
Tollygunge	12.45	0.25	0.70
Salt lake	368.56	1	10.96
Overall	482.66	0.25	6.61

102. Table – 20 shows the average time spent along with the maximum and minimum time spent by the households in each location. Hospitalisation days reported by 6 households were also included with this. The average time spent seeking medical services was found to be 6.61 hours per household in the last year.

103. The established practice is to assign value based on the prevailing market wage rate for monetising lost time of employed individuals. However, evaluating the time of the non-employed presents a challenge as there is no readily available labour market benchmark. There is a lack of universally accepted norms for such cases. The current study aligns with the approach taken in a World Bank (2001) study in Kolkata, setting the imputed value of lost time at Rs.2 per hour for both employed and non-employed individuals. After adjusting for inflation, the present study has set the imputed value of the lost time as Rs.5 per hour. Table – 21 shows the yearly monetary valuation of lost time for each location.

Table – 21: Yearly monetary valuation of lost time for each location (in rupees)

Location	Maximum	Minimum	Average
Shyambazar	1831.05	5	55.60
Dunlop	1232.90	5	28.25
Gariahat	2413.30	2.5	50.95
Behala	71.80	5	5.25
Tollygunge	62.25	1.25	3.50
Salt lake	1842.80	5	54.80
Overall	2413.30	1.25	33.05

104. 7.3. Estimating Yearly Average Cost of Illness per Household (in rupees)

105. Yearly average cost of illness = Out-of-pocket cost of medical treatment + Opportunity cost of lost time

106. = (Expenditure of non-prescribed medicine + Expenditure of treatments advised by doctor) + Opportunity cost of lost time

107. = [{Expenditure of non-prescribed medicine + (Expenditure of doctor's fees + Expenditure of medications advised by the doctor + Expenditure Due to Diagnostic Examination + Transportation cost + Expenditure of hospitalisation)} + Opportunity cost of lost time]

108. = [{41.98 + (204.15 + 340.06 + 79.12 + 30.90 + 663.46)} + 33.05]

109. = 1392.72 rupees.

110. Hence, the monthly average cost of illness = 116.06 rupees.

111. 8. Policy Implication and Conclusion

112. Kolkata is in the process of using environmentally friendly vehicles and other machinery. However, this process is not smooth and politically constrained. Residents of Kolkata face airborne diseases. An improvement programme in air quality is expected to reduce health costs significantly. There is enough scope to mobilise resources from citizens to implement an air quality improvement programme. This study can give a rough estimate of how much the people of Kolkata pay for health care due to poor air quality. The estimation plays a crucial role in determining public policy. Broadly this study helps to build an idea regarding the preference of residents. Depending on the report of the proposed study, the government can think of a pollution tax structure. A pollution tax is levied on polluters to reduce the damage to the environment. Currently, no tax is enforced in India for air pollution. An Environment Compensation Charge was implemented by the National Green Tribunal to curb the increasing automobile emissions in New Delhi. This study can shed some light on implementing a strategy against air pollution by using either tax or subsidy.

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114. References

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