DETERMINANTS OF AIR POLLUTION AND ITS IMPACT ON HEALTH IN COIMBATORE CITY

BY

SUBHASHINI. M.S.

(14PEC009)

A DISSERTATION SUBMITTED TO

AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER EDUCATION FOR WOMEN

COIMBATORE-641043

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF ARTS IN ECONOMICS

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CHAPTER I

INTRODUCTION

The development of industries and agriculture are essential for economic development of a nation. But the development of industries and other human activities causes environmental degradation. In the environmental degradation, air pollution is one of the components. The air is polluted due to various contaminants. Various contaminants continuously enter the atmosphere through both natural and manmade activities. The substances, which interact with the environment to cause toxicity, diseases, aesthetic distress have been labeled as **"pollutants".** According to the Bureau of Indian Standards, air pollution is defined as "the presence in ambient atmosphere of substances, generally resulting from the activity of man, in sufficient concentration, present for a sufficient time and under circumstances such as to interfere with comfort health or welfare of persons or with reasonable use or enjoyment of property". (Vedamadavan, 2012).

The World Health Organization (WHO) defines air pollution as "the presence of material in air in such concentration which are harmful to man and his environment". The sources of air pollution are broadly classified as natural sources such as dust storm, forest fires, volcanoes, sea spray, plant pollen etc and manmade sources (domestic & industrial) (Vedamadavan, 2012). The table -1 shows the pollutants and their sources.

TABLE - 1
AIR POLLUTANTS AND THEIR SOURCES

POLLUTANT	SOURCES
Sulphur Dioxide	Coal and oil combustion, sulphuric acid plants, biological decay of sulphide, bacteria
Nitrogen Oxides	Coal and oil combustion, automobile exhausts, electrical Storms
Suspended Particles (ash, soot, smoke)	Incinerators and almost every manufacturing process, Natural Volcanic eruption, forest fire, sea salt
Carbon Monoxide	Burning of coal, gasoline, motor exhausts, Industrial process mainly for boilers, organic chemical industries
Hydrogen sulphide	Refineries, chemical industries and bituminous fuels, sewage treatment plant
Hydrogen cyanides	Blast furnace, fumigation, chemical manufacturing, metal plating etc,.
Ammonia	Explosives, dye making, fertilizer plants and lacquers
Aldehydes	Thermal decomposition of oils, fats or glycerds
Phosgene or carbonyl Chloride	Chemical and dye making
CFC (Chloro Fluro Carbon)	Refrigerant, cleaning solvent

Source: Central pollution control board, 2012.

The air pollution is classified as three types such as point source, line source and area source based on shape of entry of pollutants. The air pollution is relatively more emotional than water pollution. The air pollution directly affects respiratory systems. Air pollution damages the property which includes a wide range-corrosion of metals, soiling

and eroding of building surfaces, fading of dyed materials, rubber cracking. Carbon dioxide intercepts outgoing long wave radiation from the earth. The earth is warmed by 0.2ºC to 0.3ºC (green house effect) by every 10% increase in CO_2. Fine particles scatter incoming short wave radiation from the sun and also absorb part of the incoming energy. This causes a cooling of 2º to 3º C in a century. Urbanization increases heat retention making the cities warmer than the countryside. Vaporization from wet cooling towers increases atmospheric humidity. Condensation and freezing nuclei alter cloud precipitation characteristics.

The air quality is measured based on three components such as the nitrogen oxide, sulphur oxide and PM_{10}. The table -2 shows the annual average concentration of major pollutants of air in states and union territories in 2012.

TABLE - 2
ANNUAL AVERAGE CONCENTRATION OF MAJOR POLLUTANTS OF AIR IN STATES AND UNION TERRITORIES DURING 2011-2012
(Residential/ Industrial/ Rural/ Other Sensitive Area)

S.NO.	STATES & UNION TERRITORIES	SULPHUR DIOXIDE		NITROGEN DIOXIDE		PARTICULATE MATTER	
		Annual Average ($\mu g/m^3$)	Standard Deviation	Annual Average ($\mu g/m^3$)	Standard Deviation	Annual Average ($\mu g/m^3$)	Standard Deviation
1	Andhra Pradesh	7	5	18	5	72	26
2	Assam	6	2	13	4	72	60
3	Bihar	6	4	36	22	166	87
4	Chandigarh (UT)	2	0	19	7	110	52
5	Chattisgarh	11	1	26	2	151	15
6	Dadra & Nagar Haveli	8	0	20	1	-	-
7	Daman & Diu (UT)	8	0	20	1	-	-
8	Delhi (UT)	5	3	59	14	237	116
9	Goa	11	3	17	4	96	49
10	Gujarat	15	2	26	4	94	20
11	Haryana	9	3	23	7	147	52
12	Himachal Pradesh	2	1	15	11	99	75
13	Jammu & Kashmir	6	3	12	5	119	41
14	Jharkhand	23	3	41	4	173	47
15	Karnataka	9	1	20	4	83	39
16	Kerala	4	1	13	4	55	28
17	Madhya Pradesh	14	2	22	5	128	37
18	Maharashtra	17	6	33	11	105	44
19	Meghalaya	9	2	11	3	73	16
20	Mizoram	2	0	7	3	54	25
21	Nagaland	2	0	6	2	86	37
22	Orissa	4	1	17	3	82	26
23	Punjab	10	2	27	5	162	46
24	Puthucherry (UT)	8	1	14	2	42	9
25	Rajasthan	8	3	34	8	173	82
26	Tamil Nadu	11	5	21	8	73	27
27	Uttar Pradesh	12	3	29	7	184	55
28	Uttarakhand	26	2	28	4	162	76
29	West Bengal	12	7	58	17	137	87

Source: Central Pollution Control Board, Ministry of Environment & Forests, 2012.

The concentration of sulphur dioxide in the air was found to be higher in the state of Uttarakhand followed by Jharkhand, Maharashtra, Gujarat, Madhya Pradesh, Uttar Pradesh, west Bengal, Chattisgarh, Goa and Tamil Nadu. The sulphur dioxide was more than 10µg/m^3 in all the above states & union territories. In the remaining states and union territories, the level of sulphur dioxide in air was 10µg/m^3 or less than 10µg/m^3. The sulphur dioxide was less than the standard level among the states and union territories.

The highest level of nitrogen dioxide in air was observed in Delhi, followed by west Bengal and Jharkhand. In these places, the level of nitrogen dioxide was observed to be 59µg/m^3, 58µg/m^3 and 41µg/m^3. In these places, the existing level of nitrogen dioxide exceeded the standard level. The level of nitrogen dioxide in air crossed 30µg/m^3 in the states/ union territories of Bihar, Maharashtra and Rajasthan. In the state of Nagaland, it was only 6µg/m^3. It was less than nitrogen dioxide level in other states and union territories.

The level of particulate matter crossed the standard level in all most all the states and union territories except in Kerala, Mizoram and Puducherry. In all the states and union territories except Kerala, Mizoram and Puducherry, the particulate matter exceeded 60µg/m^3. In Kerala it was 55µg/m^3, in Mizoram, it was 54µg/m^3 and in puthucherry, it was 42µg/m^3. The value of standard deviation pertaining to particulate matter showed a higher variation across the states and union territories.

The minimum level of sulphur dioxide was higher in the state of Uttarakhand followed by the states and union territories of Jharkhand, Gujarat and Chattisgarh. In the remaining states and union territories, the minimum level of sulphur dioxide was less than 10µg/m^3. The maximum level of sulphur Dioxide was higher in the state of Maharashtra followed by the states and union territories of Jharkhand, West Bengal and Andhra Pradesh. In the remaining states and union territories, the maximum level of sulphur dioxide was less than 30µg/m^3.

The minimum level of nitrogen dioxide was higher in the states and union territories of Rajasthan followed by Delhi, Jharkhand, West Bengal, Assam, Uttarakhand, Punjab, Chattisgarh, Gujarat and Himachal Pradesh. The minimum level of nitrogen dioxide in Rajasthan was 31µg/m^3, in Delhi as 30µg/m^3, Jharkhand -28µg/m^3, West Bengal -25µg/m^3 and Assam – 25µg/m^3. The maximum level of nitrogen dioxide had crossed 100µg/m^3 in the states and union territories of Bihar and Delhi. In the remaining states and union territories, maximum level of the nitrogen dioxide was less than 100µg/m^3.

The minimum level of particulate matter was higher in the states and union territories of Rajasthan, Chattisgarh and Punjab. In the above states and union territories, the minimum level of particulate matter was higher than 100µg/m^3. In the remaining states/union territories, the minimum level of particulate matter was less than 100µg/m^3. The maximum level of particulate matter was higher in Delhi compared to other states and union territories. The maximum level of particulate matter exceeded the standard level in all the states/union territories. The above showed that the nitrogen dioxide in some states and particulate matter in many states were the major pollutants of air.

The analysis of the World Health Organization showed that the air pollution caused 800,000 deaths and 4.6 million lost life per annum. Developing nations are particularly affected by air pollution; as many as two thirds of the deaths associated with air pollution on a global scale occur in Asia (Hosamane and Desai, 2013).

TABLE - 3

MAJOR AIR POLLUTANTS AND THEIR EFFECT ON PUBLIC HEALTH

OUTDOOR AIR POLLUTANT	MAJOR HEALTH CONCERN	POLLUTANT SOURCES
Suspended particulate matter (SPM, PM_{10}, $PM_{2.5}$)	Disrupts lung's gas exchange function and causes respiratory illness.	Mixture of solid and liquid organic plus inorganic materials including sulphate, nitrates, ammonia, sodium chloride, carbon, mineral dust and water.
Nitrogen dioxide (NO_2)	Long-term intake is toxic, reduces lung function and causes bronchitis in asthmatic Children.	Part of $PM_{2.5}$ and O_3, found in nitrate aerosols, produced by burning fuels, electricity generation plus vehicle engines.
Lead (PB)	Damages nervous system in children.	Petrol, diesel, lead batteries, paints, and coloring agents
Carbon Monoxide (CO)	Lowers blood oxygen levels, slows reflexes, increases confusion and sleepiness.	Cigarettes plus burning petrol, diesel, and wood.
Carbon Dioxide (CO_2)	Lowers oxygen levels, reduces respiratory and brain functions, causes vision defects.	Burning coal, oil and natural gases.
Ozone (O_3)	Increases respiratory infections (colds, pneumonia), breathing difficulties and asthma.	Part of photochemical smog produced by the interaction of sunlight and air pollutants.
Sulphur dioxide (SO_2)	10 minute exposure decreases pulmonary function. Causes eye irritation and respiratory inflammation (coughing, infections, mucus secretion, asthma attacks, and bronchitis).	Burning fossil fuels and industrial processes.

Source: World Health Organization, 2000.

The data available from the Central Pollution Control Board (CPCB) indicate that the levels of small particles less than 10 micron (PM_{10}) are very high. This size of particulates is known to cause severe damage to the lungs. In fact, the World Health Organization (WHO) reports that there is no safe level for particulate matter emissions,

international studies have confirmed association between elevated levels of particulate matter air pollution and decline in lung function or increase in respiratory symptoms such as cough, shortness of breath, wheezing and asthma attacks. Studies have also found associations between particulate matter air pollution and rates of hospitalization, chronic obstructive pulmonary disease and restricted activity due to illness (Dockery et al 1993).

The new scientific information emerging from international studies indicates that the cancer causing potential of diesel exhaust is very high. The Scientific Review Panel of the California Air Resources Board point out based on human epidemiological data, that a chronic exposure to 1 mg/cm^3 of diesel exhaust will lead to 300 additional cases of lung cancer per million people. World Health Organization (WHO) also reports that chronic exposure to 1 mg/cm^3 of diesel exhaust can lead to lung cancer. World health organization has estimated the guideline value for major air pollutants. It is shown in Table 4.

TABLE - 4

WHO GUIDELINE VALUES FOR MAJOR AIR POLLUTANTS

AIR POLLUTANTS	LONG TERM MEAN VALUE	SHORT TERM MEAN VALUE
$PM_{2.5}$	10µg/m^3 annual	25µg/m^3 24 – hours
Particulate matter	20µg/m^3 annual	50µg/m^3 24 – hours
O_3	-	100µg/m^3 8 – hours
Nitrogen dioxide	40µg/m^3 annual	200µg/m^3 1 – hour
Sulphur dioxide	20µg/m^3 24 – hour	500µg/m^3 10 – minutes

Source: World Health Organization, 2000.

In India, the particulate matter is the major pollutant of air and exceeded the minimum prescribed level. In this backdrop, earlier studies had attempted to assess the impact of air pollution on health at macro level. The studies on the impact of air pollution on health at micro level were rare. In this back drop, an attempt was made to assess the impact of air pollution on health in Coimbatore city.

The following are the specific objectives of the study.

1. To analyse the trend in the air quality in Coimbatore city.
2. To assess the socio economic profile of selected households.
3. To identify the determinants of air pollution.
4. To study the association between the air pollution and health.

The following hypotheses were tested to fulfill the objectives.

1. The air pollution was independent from the selected socio – economic and pollution related factors.
2. There was no association between the air pollution and the health problem.

CHAPTER II

REVIEW OF LITERTURE

The review of literature for the present study is discussed under the following heads:

I. Studies on air pollution.

II. Studies on impact of air pollution on health.

I. STUDIES ON AIR POLLUTION:

Senthilnathan, (2008) assessed the air quality in Chennai city. Study was concentrated in two places such as Anna Nagar and Kilpauk. The study reported that the air pollutants concentration had shown an increasing trend due to urbanization, industrialization and vehicular emission. Annual mean values of particular matter had exceeded National Ambient Air Qualities (NAAQS) values by a large amount. But gaseous pollutant concentrations were well below the recommended values.

Bishoi et al., (2009) made an attempt to calculate the Air Quality Index based on National Air Quality Index (NAQI) which incorporated the deficiencies of United States Environmental Production Agency method. The daily, monthly and seasonal air quality indexes were calculated by using both these methods. Although the index proposed by United States Environmental Production Agency (USEPA) gives an overall assessment of air quality but it does not include the combined effects (or synergistic effects) of the major air pollutants. It was observed that a significant difference existed between National Air Quality Index (NAQI) and Environmental Protection Agency Air Quality Index (EPAQI). However, NAQI followed the trends of Environmental Protection Agency Air Quality Index when plotted against time.

Croft and Melendez, (2009) studied the air quality index in the northern Mid-Atlantic region for a period of April-July, 2004. The data for the study were collected from the country of Delaware, Maryland, New Jersey, New York and Pennsylvania. The air quality index showed similar variation in all the countries.

Banerjee and Srivastava, (2010) assessed the impact of integrated industrial estates and industrialization on air quality for a period 2007-2008. The air quality index was developed based on the sulfur dioxide (SO_2), nitrogen oxides (NO_2), respirable suspended particulate matter (RPM) and suspended particular matter (SPM). Among the monitored air quality variables, suspended particulate matter revealed as the major pollutant followed by respirable suspended particulate matter with annual average concentrations of 281.8 and 137.6$\mu g/m^3$, respectively. However, the average concentrations of gaseous pollutants

(SO_2 and NO_2) were 21.1 and 21.7 µg/m^3respectively, which were lower than the prescribed national standards. The computed Air pollution index (AQI) revealed a gradual increasing trend with a range of 48.02–79.25, signifying the prevalence of moderate to heavy pollution levels.

Buchholz et al., (2010) had calculated an impact related daily air quality index (DAQx), for 15 air quality monitoring stations in Belgium, France, Germany and Luxembourg. The daily air quality index proved high degree concentration of particulate matter (PM_{10}), ozone (O_3) and nitrogen dioxide in the air. The concentrations of sulphur dioxide and carbon monoxide were less in the air.

Chauhan et al., (2010) studied the effect of industrialization, urbanization and automobile emission on ambient air quality in Haridwar and Dehradun City. The study was conducted for the period of March 2007 to February 2008. Meteorological parameter such as temperature, relative humidity, wind speed and rainfall were also recorded simultaneously during the sampling period. It was observed that the concentrations of the pollutants were high in winter when compared to summer or the monsoon seasons. It was observed that the suspended particulate matter and particulate matter levels at all selected sites exceeded the prescribed limits as stipulated by Central Pollution Control Board (CPCB), New Delhi, India. The sulphur dioxide and Nitrogen Oxide (NO_X) levels in residential, industrial and commercial areas were below the standard level.

Chattopadhyay et al., (2010) investigated the seasonal variation of ambient air quality status of Burdwan town using GIS approach. Concentration of sulphur dioxide, nitrogen dioxide and respirable suspended particulate matter (RSPM) were measured once a week for 24 hour in both pre-monsoon and post monsoon season. Statistical analysis showed the significant monsoonal effect on mean difference of respirable suspended particulate matter, sulphur dioxide and nitrogen dioxide concentration. Post-monsoon concentration of ambient sulphur dioxide and nitrogen dioxide were observed to be higher than pre-monsoon, suggesting longer residence times of these pollutants in the atmosphere due to stagnant conditions and low mixing height. On the basis of Air Quality Index (AQI), a GIS based air pollution surface model was generated in both the seasons. In the output of surface model, it was found that in post-monsoon there was a significant increase of clean and fairly clean area and decrease of moderately polluted area of the town compared to pre-monsoon.

Genc et al., (2010) studied Spatial and temporal variations in concentrations of Carbon Monoxide, Nitrogen Oxide, nitrogen dioxide, sulphur dioxide, and particulate

matter at traffic-impacted and residential stations in Ankara for 1999 and 2000. Air quality in residential areas was found to be influenced by traffic activities in the city. The correlation coefficients between air quality index and traffic activity were found to be 0.79 and 0.63 for different time periods.

Jha et al., (2010) studied seasonal variation in suspended particulate matter, sulphur oxide (SO_X) and nitrogen oxide (NO_X) at different selected sites such as CFRI campus, Jharia coalfields –North Tisra, GT Road, Indian School of Mines, Sindri. Annual average concentration of suspended particulate matter varied from site to site. Sulphur Oxide (SO_X) and Nitrogen Oxide (NO_X) also showed seasonal variations and their presence varied from site to site.

Sharma et al., (2010) concentrated two mathematical model. One was meteorology-based air quality model and another model was meteorology forecasting using neural network to forecast air quality index for next three days. Among all the models, air quality index model was satisfactory than the other model.

Shukla et al., (2010) studied the concentration of suspended particular matter, Nitrogen Oxide (NO_X) and sulphur dioxide at five different selected locations of Lucknow city. From the study, it was found that the residential zone had highest air quality index in comparison to other zone. It was observed that the value of suspended particulate matter was much higher than the standard value. The value of sulphur dioxide was much lower than standard sulphur dioxide level. The average air quality index of heavy traffic zone, commercial zone and residential zone were 119.5, 188.2 and 188.2 respectively.

Singh (2010) calculated index that measures deterioration in ambient air quality based on arbitrary scale which ranged between 0-10. The data were collected from some areas of Korba coalfields in India. The proposed air quality depreciation index had shown that the index allowed for more realistic air quality assessment as compared to national ambient air quality standards. The Air Quality Depreciation index could be a valuable tool to map periodic deterioration in air quality with respect to its potential for environmental damages. Since the air quality depreciation index was neither geographically specific nor constrained for the type or number of pollutants, it could be easily used for different situations and applications.

Kumar et al., (2011) made an attempt to express the ambient air quality of Jaipur city in the form of Air Quality Index (AQI). The data on air pollutants were collected from twelve sites in residential, industrial and commercial areas of the city. The survey was carried out to evaluate suspended particulate matter (SPM), respirable suspended

particulate matter (RSPM), sulphur dioxide (SO_2) and oxides of nitrogen (NO_X) by sampling for a period of 24 hours in winter season of the year, 2009-2010. Air Quality Index was calculated and results showed that the concentration of suspended particulate matter exceeded the permissible standards stipulated by Central Pollution Control Board (CPCB) in highly commercial or industrial zones. Apart from this, the sulphur dioxide and oxides of nitrogen (NO_X) levels in residential, industrial and commercial areas remained under prescribed limits of central pollution control board (CPCB).

Kumar and Goyal, (2011) assessed the air quality for summer, monsoon, post-monsoon and winter for the period of 7 years from 2000 to 2006. The findings of the study showed that the values of normalized mean square error were found to be 0.0058, 0.0082, 0.0241 and 0.0418 for winter, summer, post-monsoon and monsoon respectively.

Prakash and Bassin, (2011) analyzed the quality of ambient air by employing air quality index (AQI) based on suspended particulate matter (SPM), respirable suspended particulate matter (RSPM), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) for the year 2009 at three different locations in Delhi city. The results revealed that suspended particulate matter (SPM) was mainly responsible for high Air Quality Index values in all sites of Delhi which fell under the category of very poor. This could be due to rapid increase in urban population, growth of vehicular population, frequent dust storms, infrastructure development like construction of flyovers, metro rail services etc.

Subramani (2012) made a study on “Air pollution due to vehicle emission in tourism centre” Ooty the Head Quarters of Nilgiris District has a large Number of commercial and non-commercial vehicles, due to increasing industrialization and Tourism related activities. The data pertaining to carbon monoxide, hydro carbons and smoke density were collected in the study area. The emission levels of carbon monoxide, hydro carbons and smoke density of vehicle made from the year 1961 were within the permissible limits as recommended by the Environmental (Protection) Rules, 1986.

Harikrishnan et al., (2012) made a study on “Ambient Air Quality Monitoring in Hosur Town, Tamilnadu, India” The study assessed the concentration of chemicals in the air of the work environment. The microclimate was under control except during very hot climate in summer. The chemicals were under control in coir producing, automobile and food industries. The chemicals were often over the limit in brick, alloy casting, granite industries and in some of the premises of pharmaceutical industries. The results showed that PM_{10} concentration varied from 45 to127 μg/m3 where PM2.5 concentration varied from 24 to78 μg/m3. These were the highly polluting particles in work environment.

Hosamane Sateesh, Desai et al., (2013) made a study on "Urban air pollution trend in India" Rapid economic growth had brought many benefits to India; the environment had suffered, exposing the population to serious air pollution. The most watched pollutants included particular matter (PM), nitrogen dioxide (NO_x), sulphur dioxide (SO_2) and carbon dioxide (CO_2). Due to pollution, the ambient air quality in major cities in India was very poor. The annual average concentration of suspended particulate matter (PM10) was very high in Indian cities. It exceeded the standard level fixed by the world health organisation. There is an urgent need to adopt various strategies in planning air quality, total air quality control to improve urban air quality. Epidemiological studies should be taken up to show how ambient air pollution is affecting people's health and quantify this information in order to provide policy tools for air quality planning. Exposure to air pollutants is largely beyond the control of individuals and requires action by public authorities at the national, regional and even international levels. The norms for ambient air quality have been revisited and various industry specific emissions standards are to be revisited and notified from time to time.

Balashanmugam et al., (2015) made a study on "Determination of air quality index status in semi urban town, India" For the study, Virudhachalam town was selected. The Air quality was assessed based on National Ambient Air Quality Standards. The ambient air quality survey was carried out in January to December 2009. The data pertaining to sulphur dioxide (SO_2) nitrogen dioxide (NO_x) and suspended particular matter were collected from eight different locations. The level of suspended particular matter (SPM) and nitrogen dioxide (NO_x) were always found beyond the permissible limit at all the sampling sites. The air quality index was calculated using IND-AQI procedure. It was observed that the calculated Air Pollution Index values of sulphur dioxide (SO_2) fall under 'good' categories. The calculated Air Pollution Index values of suspended particular matter and nitrogen dioxide (NO_x) fall under all the four categories of very good, good, poor and very poor with varying percentages. It was observed that suspended particular matter was a critical pollutant at these three sites in Virudhachalam town.

II. STUDIES ON IMPACT OF AIR POLLUTION ON HEALTH:

Lvovsky Kseniya, (1998) made a study on "Economic cost of air pollution with special reference to India" The study showed that the cost of air pollution was higher compared to other countries. The study revealed that the air pollution had caused sickness and pre mature deaths in India.

Abraham Lingan et al., (2014) made a study on “Assessment of Air Pollution and its Impacts, in Cuddalore, India”. In the present study, suspended particulate matter (SPM), respirable suspended particulate matter (RSPM), sulphur dioxide (SO2), oxides of nitrogen (NOX) and carbon monoxide (CO) were investigated in four sites around Kammiyampet open dumping ground and a control site in Cuddalore, India. The result indicated that the concentration of SPM and RSPM in Kammiyampet were higher than National ambient air quality standard (CPCB, 2009) and there was an urgent need to regulate and monitor the ambient air quality in Cuddalore, especially around the dumping sites. The Air Quality Index (AQI) calculated for polluted sites showed that moderately polluted which was a cause of acute health impacts to the habitants.

Nowak David et al., (2014) made a study on “Tree and forest effects on air quality and human health in the United States” Trees removed air pollution by the interception of particulate matter on plant surfaces and the absorption of gaseous pollutants through the leaf stomata. Computer simulations with local environmental data revealed that trees and forests in the United States removed 17.4 million tonnes of air pollution in 2010 with human health effects valued at 6.8 billion U.S. dollars. This pollution removal equated to an average air quality improvement of less than one percent. Most of the pollution removal occurred in rural areas, while most of the health impacts were within urban areas. Health impacts included the avoidance of more than 850 incidences of human mortality and 670,000 incidences of acute respiratory symptoms.

Singh Ravinder et al., (2014) made a study on “Impact of Air Quality on Human Health in the construction sites in Delhi” Construction sites were important source of air pollution emitting pollutants like PM_{10}, etc. which adversely affected human health especially the respiratory system. The present study aimed at monitoring of PM_{10}, health condition of workers, evaluation of Air Pollution Index and development of correlation between Air Pollution Index and human health in the construction sites. The data for the study were collected from 19 construction sites in Delhi. The data were collected for the period of January 2013 to December 2013. The results of the study showed that the air pollution index pertaining to PM_{10} was higher and exceeded the standard level. The percentage of people suffering with respiratory diseases was also higher in the study area.

Prathipa and Sahaya Raja (2015) made a study on “Air Quality Assessment and Air Quality Index of Dindigul Town (Tamil Nadu), India”. The 24 hourly average concentrations of four major criteria pollutants viz., suspended particulate matter (SPM), respirable suspended particulate matter (RSPM), sulphur dioxide (SO_2) and nitrogen

dioxide (NO_x) at three different locations in Dindigul town of Tannery-Thomaiyarpuram-by pass, Commercial cum traffic-Dindigul bus stand and Residential-Lakshmanapuram had been considered for this analysis. The Air Quality Index was calculated using IND-AQI procedure. There were many different air quality indexes, which represented the global urban air pollution situation. Although the index proposed by USEPA gave an overall assessment of air quality, it did not include the combined effects (or synergistic effects) of the major air pollutants. So an attempt was also made to calculate the Air Quality Index based on Factor Analysis, National air quality index (NAQI) which incorporated the deficiencies of United states environmental production agency. (USEPA) method. The seasonal air quality indexes were calculated by using both these methods. It was observed that a significant difference existed between National air quality index and Environmental protection agency air quality index. However, National air quality index followed the trends of Environmental protection agency air quality index when plotted against season. The suspended particulate matter was mainly responsible for maximum Air quality index value in all three sites. The National air quality index value ranked higher at traffic and tannery site during summer and winter season. Similarly the Environmental protection agency air quality index ranking showed higher ranking at commercial cum traffic- bus stand at both seasons. It was well clear that commercial cum traffic and tannery area were found to be unhealthy and the higher ranking showed the increased pollution levels and worsening of the air quality.

Nagdeve Dewaram, (2002) made a study on “Environmental and health in India” Rapid population growth, industrialization and urbanization in country had adversely affected the environment. The secondary data were collected for fifty years to analyse the relationship between the population growth, industrialization and urbanisation. The population growth had caused deforestation, land degradation, air, and water pollution. The air and water pollution had caused health effects. The considerable magnitude of air and water pollution increased the number of people suffering from respiratory and water borne diseases and many a times led to deaths and serious health hazards. The study suggested that there was a urgent need to control population and environmental pollution in the country for better health of present and future generation.

Bency and jansy et al., (2003) made a study on “The Air pollution Related human diseases in Thiruvananthapuram city, Kerala”. The study area was divided into three zones namely; residential, commercial and industrial, based on livelihood patterns in order to compare the health impacts in different human activity areas resulting from various types

of pollution. The data showed an increasing trend in respiratory diseases with decreasing air quality. The hospital records also supported for the results obtained from the field study. The industrial effluent gases and low indoor air quality played a key role in the industrial area, while vehicular pollution and congested housing patterns were the main factors in other zones. The children and elderly were the main victims of the respiratory diseases.

Ghosh Arkadipta and Mukherji Arnab, (2006) studied "Air Pollution and Child Health in Urban India" The data for the study were collected for six cities from National Family Health Survey (2005-2006). The study addressed simultaneity child health outcomes and potential endogeneity of city-level air pollution by using a bivariate probit regression framework with city fixed effects. The findings showed that an increase in ambient air pollution significantly increased child morbidity and the type of cooking fuel used at home (usual measure of indoor pollution) was not a significant determinant of child morbidity. The findings suggested that targeted city-wide reductions in ambient air pollution could play an important role in improving child health.

Kumar Parmod and Kumar Surender, (2007) made a study on "Valuing the Health Effects of Air Pollution from Agricultural Residue Burning" Consumer choice model was used to get the monetary estimates of reduced air pollution level to the safe level. The study used data of 625 individuals collected from a household level survey conducted in three villages in Indian Punjab. To obtain the monetary values, the bit and poison models were used to estimate mitigation expenditure and workdays lost equations, respectively. It was found that the total annual welfare loss in terms of health damages due to air pollution caused by the burning of rice straw in rural Punjab amounted to Rs.76 millions. The burning of agricultural waste had caused the health effects.

Maharajan and Samual Kirubakaran, (2010) made a study on "Impact of environmental pollution on health: A sociological study in Tuticorin industrial town, Tamilnadu, India" The study highlighted impact of environmental pollution on Health. The important major industries were sterlite, SPIC, Tuticorin Alkali chemicals, Dharangadhra chemicals work, Madura coats and Kilburn chemicals industries. They were engaged in the production of cotton, staple yarn, caustic soda, PVC Resin, fertilizers, soda ash, carbon-di-oxide gas in liquid etc., The public sector undertakings were the Thermal power unit (620mm), Heavy water plant and port trust. The district contributed 70 percent of the total salt production of Tamil Nadu and met 30 percent of salt requirement of our country. The existence of above industries had caused skin diseases, eye irritation, asthma,

deftness, allergy, unhygienic conditions, respiratory problems, cancer, and hypertension diseases.

Rizwan Reza and Gurdeep Singh, (2010) studied the impact of industrial development on surface water resources and health in Orissa. The finding of the study showed the industrial effluences contributed to the environmental deterioration on the river water quality. It adversely affected the human health and aquatic eco system directly or indirectly.

Thakur Anita, (2012) studied role of women in controlling environmental pollution at household level. The health problems in India and other developing countries were due to lack of knowledge and awareness regarding the environment and its influence on human life. The study stated that residential environment played a crucial role in the improvement of environmental sanitation. In the study, it was found that women played a vital role in the promotion of environmentally responsible behaviour in the residential setting and also in activities related to preservation of natural resources.

Priyanka Rai et al., (2013) made a study on "Quantifying the Cement Air Pollution related Human Health diseases in Maihar city, Madhya Pradesh, India" The data pertaining to components of air pollution were collected at five different locations of Bus stand, Labours colony, Maihar cement colony, Railway colony and Rewa road. It was found that at Maihar city, primary pollutants such as sulfur dioxide and nitrogen oxides were found within the standard value and suspended particulate matter (SPM) exceeded the standard value prescribed for residential and rural uses by Central pollution control board (CPCB), New Delhi. Maximum concentration of suspended particulate matter, sulphur dioxide and oxide of nitrogen were found during winter months, moderate during summer and minimum during monsoon months. There was association between cement air pollution and occurrence of diseases. Result showed the maximum incidence of respiratory diseases (such as tuberculosis, bronchitis, cough, asthma etc.) compared to other diseases among the affected people.

Biju and Vijayan, (2014) made a study on "estimation of health impact due to air pollution in Thiruvananthapuram City" The air quality of Thiruvananthapuram city was assessed and it fell in the border range of moderately polluted. The principal component of pollution in the city was suspended particulate matter. The trends of Air pollution index values showed high fluctuations according to the season. Traffic volume study showed that two wheelers were the major contributors of carbon monoxide, methane, particulate matter and hydrocarbons. Carbon dioxide was mainly contributed by cars and nitrogen

dioxide and sulphur dioxide by buses. The health effects due to the exposure to PM_{10} was evaluated using dose-response coefficient and it found that the mortality and morbidity effect was very severe and need immediate attention of authorities.

Gnanasekaran, et al., (2015) made a study on "Morbidity and Mortality of air pollution from tanneries in Vellore district in reference to the respiratory syndromes". In Vellore district, Vaniyambadi, Ambur, Pernambut, Ranipet and Walajapet were selected. The period of the study was from 2007 to 2012. The findings of the study showed that the children were affected 10 – 15 percent, adolescent about 15 percent, adults about 20-25 percent and old age about 8-12 percent due to air pollution. The high morbidity and mortality rate were found among the tannery workers and dwellers in nearby industrial areas in Vaniyambadi and Ranipet. Its slowed significant impact of air pollution on health in the study area.

CHAPTER III

METHODOLOGY

The methodology pertaining to the study on "**Impact of Air Pollution on Health in Coimbatore City"** is discussed under the following heads.

3.1 Selection of area.

3.2 Selection of the sample and collection of data.

3.3 Specification of econometric model.

3.4 Limitations of the study.

3.1. SELECTION OF THE AREA

Growth of vehicles is one of the major causes of air pollution. The earlier studies had proved that the cities with high number of cars had attributed to more air pollution particularly to higher level of particulate matter. The PM_{10} concentration was higher in the cities of higher average number of cars. The world Health Organization had conducted a study which showed that Coimbatore was one of the city with high number of motor vehicles. The number of motor vehicles in the city was more than the national average. The study stated that the high number of vehicles in Coimbatore had caused to increase the level of PM_{10} above the standard limit. The high level of PM_{10} caused health problem. Hence Coimbatore city was selected for the study.

3.2. SELECTION OF THE SAMPLE AND COLLECTION OF DATA

The data for the study were collected from both primary and secondary sources. For collecting primary data, the sampling technique adopted in the study was multi stage random sampling technique. In the first stage, Coimbatore city was selected as air pollution was above the standard limit. In the Coimbatore city, the air quality was monitored by the Pollution control Board by taking samples in various sites, of residential, commercial and industrial areas. Among the sites of commercial area, it was found that the level of air pollution was higher in the area of Town hall, Gandhipuram and Ukkadam. Hence, in the second stage, the above three areas such as Town hall, Gandhipuram and Ukkadam were selected for the present study. These three areas were classified as air polluted area. Perur in Coimbatore is far away from the city and was identified as one of the non air polluted area. Hence to assess the impact of air pollution on health, Perur was selected. In the next stage, from the polluted area such as Town hall, Gandhipuram and Ukkadam, 50 respondents were identified randomly and selected to assess the views about

the impact of air pollution on health. From the non polluted area of Perur, another 50 respondents were selected randomly. In the post stratification, it was found that around 96 per cent of the sample responses fell in the occupational categories of office and factory staffs. As the responses of the respondents from the other occupational groups other than office and factory staffs were very poor, they were omitted from the sample. Again for responses from the same occupational categories of office and factory staffs, 4 respondents were selected and were added to the sample. Hence the total sample size was one hundred. The distribution of sample respondents in the study area is shown in table – 5.

TABLE - 5

DISTRIBUTION OF SAMPLE RESPONDNETS

AREA	OCCUPATION	NUMBER OF RESPONDENTS
Polluted: Town hall	Office staffs	7
	Factory staffs	13
	Total	20
Gandhipuram	Office staffs	8
	Factory staffs	12
	Total	20
Ukkadam	Office staffs	5
	Factory staffs	5
	Total	10
Non Polluted: Perur	Office staffs	13
	Factory staffs	37
	Total	50
Total	Office staffs	28
	Factory staffs	72
	Total	100

Source: Estimated from the field survey, 2015 – 16.

The primary data were collected from the hundred respondents based on personal interview method by administering pre tested interview schedule. A pilot study was conducted to identify the gabs in the interview schedule. The final interview schedule contains the details on socio economic profile, determinants of air pollution, consequences of air pollution and health impacts. The survey was conducted in the months of December, 2015 and January, 2016. The secondary data on trends in air quality in Coimbatore city were collected from the Air Pollution Data Base of Tamil Nadu, 2014, the Department of Environment, Government of Tamil Nadu and Pollution Control Board, Tamil Nadu.

3.3. SPECIFICATION OF ECONOMETRIC MODEL

LOGISTIC REGRESSION ANALYSIS

In the present study, an attempt was made to assess the determinants of air pollution. The dependent variable, air pollution was a dummy variable indicating presence of air pollution and absence of air pollution. As the dependent variable was a dummy variable, the use of linear regression to identify the determinants of air pollution would be biased. The air pollution equation was specified as the logistic regression equation in the present study. The form of the logistic regression equation estimated in the study was

$$G^* = yz + \varepsilon$$

where,

G=Probability of area being air polluted and non air polluted

Y=Parameter co-efficient

Z= Size of population (number), number of industries, income of household (Rs.), number of motor vehicles in the road per day, hours of cooking per day, energy consumption expenditure (Rs.), using of air conditioner at home (number) and exhaust fan at home (number).

ε = is a random disturbance term.

CHI SQUARE TEST

The chi square test was applied to assess the association between the air pollution and the perception of respondents about the health problem. The same chi square test was used to assess the association between the air pollution and the health problems faced by the respondents. The formula for chi square test was

$$\chi^2 = \frac{\Sigma (O-E)^2}{E}$$

O = Observed frequency

E = Expected frequency

Simple percentages and averages were also used along with the above econometric tools.

3.4. LIMITATIONS OF THE STUDY

1. The present study was based on the data collected for Coimbatore city. The findings may not be true at macro level.
2. The air quality data for the period 2015 -2016 for Coimbatore city was not available.
3. The time series data on the diseases for sample sites such as Town hall, Gandhipuram, Ukkadam and Perur were not available. If the time series data for sample sites were available, it would be possible to assess the long period impact of air pollution on health.
4. The responses of the respondents were based on the recall method. It would reveal only approximated information.
5. The seasonal variations in the air quality in Coimbatore city was not assessed.
6. The perception of the respondents about the health problems due to air pollution could be analysed by using rating scale. Similarly, the responses of the respondents pertaining to the occurrence of the diseases could be ranked and measured. In the present study, only the number of responses were calculated and analysed.

CHAPTER IV

RESULT AND DISCUSSION

Results pertaining to the study on **'Impact of Air Pollution on Health in Coimbatore City'** are discussed under the following headings.

I. Results based on Secondary Data:

4.1. Trends in ambient air quality in Town hall and Ukkadam (2003-2012)

4.2. Trends in ambient air quality in Gandhipuram in Coimbatore

4.3. Trends in ambient air quality in the industrial area of Coimbatore District

4.4. Air quality in residential zone of Coimbatore 2014-2015

4.5. Air quality in commercial zone of Coimbatore 2014 – 2015

4.6. Air quality in industrial zone of Coimbatore 2014 – 2015

II. Results based on Primary Data:

4.7. Average number of years staying by the respondents in the study area

4.8. Socio economics profile of respondents in polluted and non-polluted area

4.9. Causes of air pollution

4.10. Determinants of air pollution in the study area – logistic regression analysis

4.11. Perception of respondents about the consequence of air pollution on health in the study area

4.12. Family members suffered from diseases

4.13. Health problem experienced by the respondents in the study area

4.14. Consequences of air pollution other than diseases

4.15. Association between the air pollution and perception of health problem - chi square test

4.16. Association between the air pollution and health indicators in study area – chi square test

I. RESULTS BASED ON SECONDARY DATA

4.1. TRENDS IN AMBIENT AIR QUALITY IN TOWN HALL AND UKKADAM (2003 - 2012)

The trends in ambient air quality in Town hall and Ukkadam are shown in table – 6

TABLE - 6
TRENDS IN AMBIENT AIR QUALITY IN TOWN HALL AND UKKADAM (2003-2012)

YEAR	ANNUAL AVERAGE CONCENTRATION OF AIR POLLUTANTS (µg/m^3)			
	TSPM	RSPM	NOx	SO_2
2003 – 2004	111	46	46	10
2004 – 2005	113	51	41	7
2005 – 2006	86	44	38	7
2006 – 2007	87	44	32	9
2008 – 2009	90	50	31	5
2009 – 2010	98	51	23	5
2010 – 2011	111	56	21	5
2011 – 2012	NA	68	29	5
Prescribed Standard				
NAAQS – 2009	140	60	40	50

Source: Air pollution data base, 2014 – 2015.

Note: TSPM - Total Suspended Particulate Matter, RSPM - Respirable Suspended Particulate Matter, NO_X - Nitrogen oxide, SO_2 - Sulfur dioxide, NAAQS – National Amibient Air Quality Standard.

The level of total suspended particulate matter (TSPM) in Town hall and Ukkadam was ranged between 86 µg/m^3 and 113 µg/m^3 in the period 2003 – 2004 and 2010 – 2011. The level of respirable suspended particulate matter (RSPM) had varied between 44 µg/m^3 and 68 µg/m^3 in the period of 2003 – 2004 and 2011 – 2012. The value of respirable suspended particulate matter (RSPM) had exceeded the prescribed level in Town hall and Ukkadam in 2012. The value of nitrogen oxide and sulfur dioxide had declined in the period of 2003 – 2004 and 2011 – 2012. The value of nitrogen oxide had declined from 46 µg/m3 in 2003-2004 to 29µg/m^3 in 2012. It had exceeded the standard limit in the period 2003 – 2005. The value of sulfur dioxide had declined from 10 µg/m^3 in 2003 – 2004 to 5 µg/m^3 in 2012. The above trends revealed that respirable suspended particulate matter (RSPM) and nitrogen oxide were the major pollutants of air in Town hall and Ukkadam.

4.2. TRENDS IN AMBIENT AIR QUALITY IN GANDHIPURAM IN COIMBATORE

The component of air quality consists of total suspended particulate matter (TNPM), respirable suspended particulate matter (RSPM), nitrogen oxide and sulfur dioxide. The trends in total suspended particulate matter (TSPM), respirable suspended

particulate matter (REPM), nitrogen oxide and sulfur dioxide for the period of 2003 – 2004 and 2011 -2012. It are shown in table – 7.

TABLE – 7

TRENDS IN AMBIENT AIR QUALITY IN GANDHIPURAM IN COIMBATORE

YEAR	ANNUAL AVERAGE CONCENTRATION OF AIR POLLUTANTS (µg/m^3)			
	TSPM	RSPM	NO_X	SO_2
2003 – 2004	108	43	51	10
2004 – 2005	134	53	39	7
2005 – 2006	90	39	43	8
2006 – 2007	88	44	32	10
2008 – 2009	107	59	30	5
2009 – 2010	121	60	23	5
2010 – 2011	157	60	24	6
2011 – 2012	NA	68	30	5
Prescribed Standard				
NAAQS – 2009	140	60	40	50

Source: Air pollution data base, 2014 – 2015.

Note: TSPM - Total Suspended Particulate Matter, RSPM - Respirable Suspended Particulate Matter, NO_X - Nitrogen oxide, SO_2 - Sulfur dioxide, NAAQS – National Amibient Air Quality Standard.

The level of total suspended particulate matter (TSPM) had shown fluctuating trend in the period 2003 – 2012. It had increased from 108 µg/m^3 in 2003 – 2004 to 157 µg/m^3 in 2010 – 2011. Similarly respirable suspended particulate matter (RSPM) had also shown fluctuating trend. It had increased from 43 µg/m^3 in 2003 – 2004 to 68 µg/m3 in 2011 – 2012. But nitrogen oxide and sulfur dioxide had declined in the period of 2003 – 2012. The level of total suspended particulate matter (TSPM) and respirable suspended particulate matter (RSPM) had exceeded the prescribed level in 2010 – 2011 and in 2011 – 2012 respectively. The level of nitrogen oxide was within the prescribed level in all the time periods except during the year 2003 – 2004 and 2005 – 2006. The level of sulfur dioxide was within the prescribed limit in all the time period. It showed that total suspended particulate matter (TSPM) and respirable suspended particulate matter (RSPM) were the important pollutants of air in Gandhipuram along with nitrogen oxide.

4.3. TRENDS IN AMBIENT AIR QUALITY IN THE INDUSTRIAL AREA OF COIMBATORE DISTRICT

The trends in ambient air quality in the industrial area of Coimbatore district are shown in table – 8.

TABLE – 8
TRENDS IN AMBIENT AIR QUALITY IN THE INDUSTRIAL AREA OF COIMBATORE DISTRICT

YEAR	ANNUAL AVERAGE CONCENTRATION OF AIR POLLUTANTS (µg/m^3)			
	TSPM	RSPM	NO_X	SO_2
2003 – 2004	151	62	56	13
2004 – 2005	192	84	48	9
2005 – 2006	161	73	47	10
2006 – 2007	230	102	40	11
2008 – 2009	221	116	37	6
2009 – 2010	231	100	27	7
2010 – 2011	273	102	34	6
2011 – 2012	NA	205	35	5
Prescribed Standard				
NAAQS – 2009	140	60	40	50

Source: Air pollution data base, 2014 – 2015.

Note: TSPM - Total Suspended Particulate Matter, RSPM - Respirable Suspended Particulate Matter, NO_X - Nitrogen oxide, SO_2 - Sulfur dioxide, NAAQS – National Amibient Air Quality Standard.

The table - 8 showed that the total suspended particulate matter (TSPM) and respirable suspended particulate matter (RSPM) had increased in the period from 2003 – 2004 to 2011 – 2012. The level of total suspended particulate matter (TSPM) and respirable suspended particulate matter (RSPM) exceeded the prescribed limit in all the time period. The level of nitrogen oxide and sulfur dioxide had declined. The major pollutants of air were total suspended particulate matter and respirable suspended particulate matter (RSPM) along with nitrogen oxide in the industrial area of Coimbatore.

4.4. AIR QUALITY IN RESIDENTIAL ZONE OF COIMBATORE, 2014-2015

Air quality in selected residential zone of Coimbatore in 2014 – 2015 was estimated by the central pollution control board, Tamil Nadu. The results of air quality in selected residential zone of Coimbatore for the year 2014 – 2015 are shown in table – 9.

TABLE - 9
RANGE OF CONCENTRATION OF POLLUTANTS AT RESIDENTIAL ZONE IN 2014 - 2015

LOCATION	SPM (ug/m^3)	SO_2 (ug/m^3)	NO_X (ug/m^3)
Anna nagar	18.93-203.70	21.58-38.89	5.32-7.64
Sowripalayam	58.05-74.63	16.16-24.69	4.23-5.31
Ganapathy	103.48-147.83	16.58-19.23	4.11-6.11
Saibaba colony	101.23- 135.48	18.34-20.46	5.23-15.28
Ram nagar	122.58-140.35	16.23-18.23	5.23-7.12

Source: Air Pollution in Coimbatore City, 2015.

Note: Suspended Particular Matter (SPM), Sulfur dioxide (SO_2), Nitrogen oxide (NO_x).

The air quality was estimated in residential zone of Anna nagar, Sowripalayam, Ganapathy, Saibaba colony and Ram nagar in Coimbatore. The lower limit of Suspended Particulate Matter (SPM) was higher in Ram nagar. The upper limit of Suspended Particulate Matter was higher in Anna nagar. In all the residential areas, the level of Sulfur dioxide and Nitrogen oxide did not exceed the minimum level prescribed by the pollution control board.

4.5. AIR QUALITY IN COMMERCIAL ZONE OF COIMBATORE, 2014 – 2015:

The level of suspended particulate matter (SMP), sulfur dioxide and nitrogen oxide in commercial zone of Coimbatore is shown in table -10.

TABLE – 10

RANGE OF CONCENTRATION OF POLLUTANTS AT COMMERCIAL ZONE IN 2014 -2015

LOCATION	SPM (ug/m^3)	SO_2 (ug/m^3)	NO_X (ug/m^3)
R.S.Puram	177.03-193.43	19.68-20.73	6.56-7.04
Gandhipuram	602.23-638.76	24.53-27.32	15.64-18.93
Peelamedu	486.18-530.49	23.14-25.06	17.64-18.20
Town hall	586.89-649.18	30.36-40.35	32.76-40.00
Ukkadam	953.36-984.54	40.35-46.96	29.19-31.04

Source: Air Pollution in Coimbatore City, 2015.

Note: Suspended Particular Matter (SPM), Sulfur dioxide (SO_2), Nitrogen oxide (NO_x).

The very important commercial zones observed in Coimbatore were R.S.Puram, Gandhipuram, Peelamedu, Town hall, and Ukkadam. In these areas, the pollution control board took sample and had calculated the air quality index. The highest level of suspended particulate matter (SPM) was observed in Ukkadam compared to other commercial areas. It was ranged between 953.36 – 984.54. It had exceeded the prescribed limit of pollution control board. In all the selected commercial area, the level of suspended particulate matter (SPM) had exceeded the prescribed limit of pollution control board. The level of Sulfur dioxide and Nitrogen oxide were within the prescribed limit in all the commercial parts.

To sum up, the air was highly polluted in the Commercial Zone of Town hall, Ukkadam and Gandhipuram due to suspended particulate matter (SPM) compared to other areas. The sulfur dioxide and nitrogen oxide were not major pollutants of air in the commercial zone of Coimbatore.

4.6. AIR QUALITY IN INDUSTRIAL ZONE OF COIMBATORE 2014 – 2015

The air quality index in the industrial zone of Coimbatore district is shown in table -11.

TABLE - 11
RANGE OF CONCENTRATION OF POLLUTANTS AT INDUSTRIAL ZONE IN 2014 - 2015

LOCATION	SPM (ug/m^3)	SO_2 (ug/m^3)	NO_X (ug/m^3)
Kannapiran Textile	123.19-132.78	23.92-27.71	6.56-7.04
Construction Zone	131-148.93	22.76-24.69	15.64-18.93
Foundry Unit	166.67-194.24	35.05-39.59	17.64-18.20
Cement Factory (ACC)	587.43-602.97	28.05-28.54	25.78-27.72
Textile Unit (Singanallur)	652.18-743.97	23.92-24.72	17.64-18.23

Source: Air Pollution in Coimbatore City, 2015.

Note: Suspended Particular Matter (SPM), Sulfur dioxide (SO_2), Nitrogen oxide (NO_x).

It was found that the level of suspended particulate matter (SPM) in all the industrial areas exceeded the prescribed limit. The level of Sulfur dioxide and Nitrogen oxide were highest in Foundry Unit and Cement Factory Unit respectively. But the level was within the prescribed limit in the above stated areas and in other industrial parts.

II. RESULTS BASED ON PRIMARY DATA

4.7. AVERAGE NUMBER OF YEARS OF STAYING BY THE RESPONDENTS IN THE STUDY AREA

The respondents were asked about the number of years of staying in the area. The details pertaining to average number of years of staying by the respondents in the study area are shown in table – 12.

TABLE – 12

AVERAGE NUMBER OF YEARS OF STAYING BY THE RESPONDENTS IN THE STUDY AREA

PLACE	OCCUPATION	MEAN (In Years)
Polluted: Town hall	Office staffs	15.71
	Factory staffs	14.85
	Total	15.15
Gandhipuram	Office staffs	13.50
	Factory staffs	13.25
	Total	13.35
Ukkadam	Office staffs	18.10
	Factory staffs	18.10
	Total	18.10
Non polluted: Perur	Office staffs	16.69
	Factory staffs	16.68
	Total	16.68

Source: Estimated from the field survey, 2015 – 16.

In polluted area, in Ukkadam, the respondents had stayed for 18 years. It was higher than the average number of years of staying of respondents in other places of polluted area. In non polluted area, the mean year of staying by the respondents was around 17 years.

4.8. SOCIO ECONOMIC PROFILE OF RESPONDENTS IN POLLUTED AND NON-POLLUTED AREA

4.8.1: AGE OF THE RESPONDENTS

The mean age of respondents in polluted and non polluted area is given in table – 13.

TABLE – 13

AGE OF THE RESPONDENTS

PLACE	OCCUPATION	MEAN (In Years)
Polluted: Town hall	Office staffs	35.00
	Factory staffs	30.23
	Total	31.90
Gandhipuram	Office staffs	27.38
	Factory staffs	30.50
	Total	29.25
Ukkadam	Office staffs	32.00
	Factory staffs	32.80
	Total	32.80
Non polluted: Perur	Office staffs	34.77
	Factory staffs	35.05
	Total	34.98

Source: Estimated from the field survey, 2015 – 16.

In polluted area, in Town hall, the mean age of office staff was 35 years and factory staffs was 30 years. In Gandhipuram and Ukkadam, the mean age of the respondents was ranged between 27 to 33 years. In non polluted area of Perur, the mean age of office and factory staffs was same as around 35 years.

4.8.2: SIZE OF FAMILY

Size of family of respondents in polluted and non polluted area, is shown in table – 14.

TABLE – 14

SIZE OF FAMILY

PLACE	OCCUPATION	MEAN (In Number)
Polluted: Town hall	Office staffs	4
	Factory staffs	4
	Total	4
Gandhipuram	Office staffs	4
	Factory staffs	4
	Total	4
Ukkadam	Office staffs	4
	Factory staffs	4
	Total	4
Non polluted: Perur	Office staffs	5
	Factory staffs	5
	Total	5

Source: Estimated from the field survey, 2015 – 16.

In polluted area, the average size of family was on an around 4 for both office and factory staffs. In non polluted area, in Perur, the mean size of family was on an around 5. It showed that the size of family was larger in non polluted area than in polluted area.

4.8.3: INCOME OF THE HOUSEHOLD

The mean monthly income of households in both polluted and non polluted area is shown in table – 15.

TABLE – 15

INCOME OF THE HOUSEHOLD

PLACE	OCCUPATION	MEAN (In Rs.)
Polluted: Town hall	Office staffs	18571.43
	Factory staffs	34769.23
	Total	29100.00
Gandhipuram	Office staffs	12000.00
	Factory staffs	11500.00
	Total	11700.00
Ukkadam	Office staffs	9200.00
	Factory staffs	9200.00
	Total	9200.00
Non polluted: Perur	Office staffs	13769.23
	Factory staffs	13810.81
	Total	13800.00

Source: Estimated from the field survey 2015 – 16.

In polluted area of Town hall, the average monthly income of the factory staffs was higher than the office staffs. In Gandhipuram, the average monthly income of office staffs

was higher than the factory staffs. In Ukkadam, there was no difference in the monthly income of the households between factory and office staffs. In non polluted area, in Perur, the average monthly family income of factory staffs was higher than the office staffs.

4.8.4: PATTERN OF HOUSE

The details pertaining to pattern of house of the respondents in both polluted and non polluted area are represented in table-16.

TABLE - 16

PATTERN OF HOUSE

PLACE	OCCUPATION	PERCENTAGE	
Polluted:		**PACCA**	**KACHA**
Town hall	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0
Gandhipuram	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0
Ukkadam	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0
Non Polluted: Perur	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0
Total	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0

Source: Estimated from the field survey, 2015 – 16.

It was found that in both polluted and non polluted area, all the 100 per cent of the households had pacca houses. None of the household was living in kacha house. It revealed better economic position of the household.

4.9: CAUSES OF AIR POLLUTION

The air pollution is caused not only by the outdoor pollution, but also by indoor pollution. The causes of indoor pollution is measured in terms of energy consumption, electricity consumption, hours of cooking, using air conditioner, heater, exhaust fan, availability of ventilation and separate kitchen. The causes of outdoor air pollution is measured in terms of number of vehicles travelled in the study area, population in polluted and non polluted areas and number of industries.

4.9.1. EXISTENCE OF SEPARATE KITCHEN

Existence of separate kitchen is one of the factors determining indoor air pollution. The responses of respondents pertaining to the existence of separate kitchen are shown in table – 17.

TABLE – 17

EXISTENCE OF SEPARATE KITCHEN

PLACE	OCCUPATION	PERCENTAGE	
Polluted:		**YES**	**NO**
Town hall	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0
Gandhipuram	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0
Ukkadam	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0
Non Polluted: Perur	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0
Total	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0

Source: Estimated from the field survey, 2015 – 16.

In both polluted and non polluted area, all the 100 percentage of the respondents had stated for the separate kitchen at home. Hence the existence of no separate kitchen was not a major factor causing air pollution in the study area.

4.9.2. ENERGY CONSUMPTION EXPENDITURE FOR COOKING

Energy consumption expenditure for cooking is one of the major factors casing air pollution.

The mean energy consumption expenditure for cooking is shown in table – 18.

TABLE - 18

ENERGY CONSUMPTION EXPENDITURE FOR COOKING

PLACE	OCCUPATION	MEAN (In Rs. per month)
Polluted: Town hall	Office staffs	680.00
	Factory staffs	680.00
	Total	680.00
Gandhipuram	Office staffs	680.00
	Factory staffs	680.00
	Total	680.00
Ukkadam	Office staffs	680.00
	Factory staffs	680.00
	Total	680.00
Non Polluted: Perur	Office staffs	689.23
	Factory staffs	680.00
	Total	682.40

Source: Estimated from the field survey, 2015 – 16.

The mean consumption expenditure for cooking in polluted area was Rs.680 per month. In non polluted area, the average monthly expense on energy consumption for cooking was Rs.689 for office staffs and Rs.680 for factory staffs. It showed that there was no much variation in the average expenses on energy consumption between polluted and non polluted area.

4.9.3: NUMBER OF TIMES COOKING PER DAY

Number of times cooking per day is one of the factor determining indoor air pollution. Hence average number of times cooking per day was calculated for both polluted and non polluted area and given in table- 19.

TABLE – 19

NUMBER OF TIMES COOKING PER DAY

PLACE	OCCUPATION	MEAN
Polluted: Town hall	Office staffs	3.00
	Factory staffs	3.00
	Total	6.00
Gandhipuram	Office staffs	3.00
	Factory staffs	3.00
	Total	6.00
Ukkadam	Office staffs	2.00
	Factory staffs	2.00
	Total	2.00
Non Polluted: Perur	Office staffs	2.00
	Factory staffs	2.00
	Total	4.00

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall and Gandhipuram, the average number of times cooking per day was three while it was two in Ukkadam. In non polluted area of Perur, the average number of times cooking per day was only two for both office and factory staffs. Hence, it revealed that the average number of times cooking per day was higher in polluted area than in non polluted area.

4.9.4: AVERAGE HOURS OF COOKING PER DAY

Average hours of cooking per day may also one of the factors determining the indoor air pollution. Therefore, average hours of cooking per day was calculated and is shown in table – 20.

TABLE – 20

AVERAGE HOURS OF COOKING PER DAY

PLACE	OCCUPATION	MEAN HOURS
Polluted: Town hall	Office staffs	2.00
	Factory staffs	2.00
	Total	4.00
Gandhipuram	Office staffs	2.00
	Factory staffs	2.00
	Total	4.00
Ukkadam	Office staffs	2.00
	Factory staffs	2.00
	Total	2.00
Non Polluted: Perur	Office staffs	2.00
	Factory staffs	2.00
	Total	4.00

Source: Estimated from the field survey, 2015 – 16.

In polluted places of Town hall, Gandhipuram and Ukkadam, the average hours of cooking was 2 hours per day. In non polluted place of Perur also, the hours of cooking was only two hours per day. It showed that there was no difference in the cooking hours per day between polluted and non polluted area.

4.9.5: MONTHLY AVERAGE ELECTRICITY CONSUMPTION EXPENDITURE

Monthly average electricity consumption expenditure was considered as one of the determinant of air pollution. The average monthly consumption expenditure in polluted and non polluted area is shown in table – 21.

TABLE – 21

MONTHLY AVERAGE ELECTRICITY CONSUMPTION EXPENDITURE

PLACE	OCCUPATION	MEAN (In Rs.)
Polluted: Town hall	Office staffs	728.57
	Factory staffs	730.77
	Total	730.00
Gandhipuram	Office staffs	643.75
	Factory staffs	591.67
	Total	612.50
Ukkadam	Office staffs	470.00
	Factory staffs	470.00
	Total	470.00
Non Polluted: Perur	Office staffs	692.31
	Factory staffs	570.00
	Total	603.13

Source: Estimated from the field survey, 2015 – 16.

In Town hall, the average monthly electricity consumption expenditure was Rs.729 for office staffs and Rs.731 for factory staffs. Similarly in Gandhipuram, it was ranged between Rs.592 and Rs.644. In Ukkadam, it was only Rs.470. In Perur, it was ranged between Rs.570 and Rs.692.

4.9.6. USING OF AIR CONDITIONER

The responses of the respondents using air conditioner are shown in table – 22.

TABLE – 22

USING OF AIR CONDITIONER

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted: Town hall	57.1	42.9	100	46	54	100	37.27	62.73
Gandhipuram	62.5	37.5	100	58	42	100		
Ukkadam	0	100	100	0	100	100		
Non Polluted: Perur	0	100	100	0	100	100	0	100
Total	27	73	100	19	81	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, 57.1 percentage of the office staffs and 46 percentage of the factory staffs had used air conditioner at home. In Gandhipuram, more than 50 percentage of the respondents had used air conditioner. In Ukkadam, none of the office and factory staffs had used air conditioner. In non polluted area also, none of the

respondents had used air conditioner. In total, higher percentage of respondents had used air conditioner in polluted area compared to other area.

4.9.7. USING OF HEATER

The responses of the respondents pertaining to using of the heater during winter season are given in table – 23.

TABLE – 23

USING OF HEATER

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted: Town hall	0	100	100	0	100	100	0	100
Gandhipuram	0	100	100	0	100	100		
Ukkadam	0	100	100	0	100	100		
Non Polluted: Perur	0	100	100	0	100	100	0	100
Total	0	100	100	0	100	100		

Source: Estimated from the field survey, 2015 – 16.

In both polluted and non polluted areas, none of the office and factory staffs had used heater during the winter. In total, none of the respondents had used heater during the winter in both polluted and non polluted areas.

4.9.8. USING OF EXHAUST FAN

The responses of the respondents using exhaust fan are shown in table – 24.

TABLE – 24

USING OF EXHAUST FAN

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted: Town hall	100	0	100	69	31	100	60.77	39.23
Gandhipuram	62.3	37.7	100	83.3	16.7	100		
Ukkadam	25	75	100	25	75	100		
Non Polluted: Perur	85	15	100	84	16	100	84.5	15.5
Total	82.1	17.9	100	76.4	23.6	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, 100 percentage of the office staffs and 69 percentage of the factory staffs had used exhaust fan at home. In Gandhipuram, more than 50 percentage of the respondents had used exhaust fan. In Ukkadam, 25 percentage of the office and factory staffs had used exhaust fan. In non polluted area of Perur, 85 percentage of the office staffs and 84 percentage of the factory staffs had used exhaust fan at home. In total, higher percentage of respondents had used exhaust fan in non polluted area compared to the polluted area.

4.9.9. AVAILABILITY OF VENTILATION

Ventilation in the houses is the important factor determining, indoor air pollution. Hence, the presence of ventilation in the study area was analysed and is shown in table- 25.

TABLE – 25

AVAILABILITY OF VENTILATION

PLACE	OCCUPATION	PERCENTAGE	
Polluted:		**YES**	**NO**
Town hall	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0
Gandhipuram	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0
Ukkadam	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0
Non Polluted: Perur	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0
Total	Office staffs	100	0
	Factory staffs	100	0
	Total	100	0

Source: Estimated from the field survey, 2015 – 16.

In both polluted and non polluted area such as Town hall, Gandhipuram, Ukkadam and Perur, all the 100 per cent of the respondents had responded for good ventilation in their homes. It indicated that non availability of ventilation was not at all a cause for air pollution in the study area.

4.9.10. NUMBER OF MOTOR VEHICLES TRAVELLED IN THE ROAD PER DAY

The table shows responses of the respondents about the number of motor vehicles travelled in the road per day.

TABLE – 26

NUMBER OF MOTOR VEHICLES TRAVELLED IN THE ROAD PER DAY

PLACE	COMMERCIAL		NON COMMERCIAL	
	OFFICE STAFFS	FACTORY STAFFS	OFFICE STAFFS	FACTORY STAFFS
Polluted: Town hall	89550	88580	1287480	1385500
Gandhipuram	88600	87570	1585400	1458500
Ukkadam	85560	85450	1265500	1245300
Non Polluted: Perur	65560	56540	65650	63500

Source: Estimated from the field survey, 2015 – 16.

In the polluted area of Town hall, the respondents responded for higher number of commercial vehicles travelled in the road per day compared to the other areas. In Gandhipuram, the respondents responded for higher number of non commercial vehicles travelled in the road per day compared to the other areas. In non polluted area of Perur, the respondents responded for very less number of vehicles travelled in the road compared to polluted areas.

4.9.11. POPULATION IN POLLUTED AND NON POLLUTED AREAS

The responses of the respondents about the size of population in the study area are shown in table – 27.

TABLE – 27

POPULATION IN POLLUTED AND NON POLLUTED AREAS

PLACE	POPULATION (In number)
Polluted: Town hall	200000
Gandhipuram	200000
Ukkadam	200000
Non Polluted: Perur	10000

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, Gandhipuram and Ukkadam, the size of population was two lakhs responded by the respondents. In the non polluted area of Perur, the size of the population was around 10,000 responded by the respondents.

4.9. 12. NUMBER OF INDUSTRIES

The responses of the respondents about the number of industries existed in the study area are shown in table-28.

TABLE – 28

NUMBER OF INDUSTRIES

PLACE	NUMBER OF INDUSTRIES
Polluted: Town hall	10
Gandhipuram	25
Ukkadam	2
Non Polluted: Perur	2

Source: Estimated from the field survey, 2015 – 16.

In the polluted area of Town hall, the number of industries was around 10 responded by the respondents. In Gandhipuram, it was around 25 industries and in Ukkadam it was around 2 responded by the respondents. In non polluted area of Perur, there were only 2 industries responded by the respondents.

4.10. DETERMINANTS OF AIR POLLUTION IN THE STUDY AREA – LOGISTIC REGRESSION ANALYSIS

Logistic regression analysis was applied to find out the probability of an area becoming air polluted and non air polluted in relation to set of variables such as total number of population, number of industries, income of household, number of motor vehicles in the road per day, hours of cooking per day, energy consumption expenditure, using of air conditioner at home and exhaust fan at home along with availability of ventilation, availability of separated kitchen, electricity consumption expenditure and using of heater. In the process of analysis, availability of ventilation, availability of separated kitchen, electricity consumption expenditure and using of heater were excluded. The results of logistic regression analysis are shown in table – 29.

TABLE – 29

DETERMINANTS OF AIR POLLUTION – LOGISTIC REGRESSION

VARIABLES	REGRESSION COEFFICIENTS	WALD	LEVEL OF SIGNIFICANCE	ODDS RATIO
Constant	-408.930	0.001	Significant at 5% level	0.000
Size of population	0.001	0.004	Significant at 5% level	1.001
Number of Industries	0.013	0.000	Significant at 5% level	1.223
Income of the house hold	0.002	4.967	Significant at 5% level	1.021
Number of vehicles in road per day	1.875	2.974	Significant at 5% level	1.889
Hours of cooking per day	0.650	0.221	Significant at 5% level	1.916
Energy consumption expenditure	0.135	2.876	Significant at 5% level	1.569
Use of air conditioner at home	0.369	0.000	Significant at 5% level	1.176
Use of exhaust fan	-2.407	3.080	Significant at 5% level	11.105
2 Log Likelihood	23.045			
Chi-square	112.771		Significant at 1% level	

Source: Estimated from the field survey, 2015 – 16.

In the logistic model, the value of 2 log likelihood was estimated. It was observed to be 23.045. The value of chi square was estimated to test the significance of 2 log likelihood co efficient and the significance of the model. The value of chi square was 112.771 and statistically significant. It indicated that all the selected variables together were statistically significant to determine the air pollution. The classification results revealed that the model predicted 96.9 percent of the determinants of air pollution. Cox and Snel and Nagelkerke R^2 values were 0.684 and 0.912 respectively. It indicated significant correlation between the selected variables and air pollution.

The estimated regression coefficients were converted into odds which are the logistic co efficient [(Exp (β)]. The logistic coefficients were greater than one for the variables such as population, number of industries, number of motor vehicles in the road per day, income of household, hours of cooking per day, energy consumption expenditure, using of air conditioner and exhaust fan at home. The above variables contributed significantly to air pollution. The increase in population, number of industries, number of motor vehicles in the road per day, income of household, hours of cooking per day, energy consumption expenditure and using of air conditioner at home would increase the

probability of area becoming air polluted. The area, with higher population, higher number of industries, higher number of motor vehicles travelled in the road per day, higher family income, higher cooking hours per day, higher energy consumption and higher usage of air conditioner was the probable air polluted area. The use of exhaust fan would reduce the probability of area to be polluted as the logistic regression co efficient was negative.

4.11. PERCEPTION OF RESPONDENTS ABOUT THE CONSEQUENCE OF AIR POLLUTION ON HEALTH IN THE STUDY AREA

Various diseases were listed such as headache, eye, nose and throat irritations, running nose, flu fever, skin infection, asthma and respiratory diseases, shortness of breath, dry scratchy throat, chest pain, cough with phlegm, dry cough, bronchitis, drowsiness, pneumonia, heart diseases and cancer as the consequences of air pollution in the study area. The perception of the respondents pertaining to various diseases are discussed as under.

4.11.1. PERCEPTION OF RESPONDENTS FOR HEADACHE AS THE CONSEQUENCE OF AIR POLLUTION

The perception of respondents pertaining to headache as the consequence of air pollution in polluted and non polluted area are shown in table – 30.

TABLE - 30

PERCEPTION OF RESPONDENTS FOR HEADACHE AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted:								
Town hall	71	29	100	69	31	100		
Gandhipuram	75	25	100	58	42	100	62.17	37.83
Ukkadam	75	25	100	25	75	100		
Non Polluted:								
Perur	92	8	100	78	22	100	85	15
Total	82	18	100	29	71	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, 71 percentage of the office staffs had perceived for headache. In Gandhipuram, 75 percentage of the office staffs and 58 percentage of the factory staffs had perceived for headache. In Ukkadam, 75 percentage of the office staffs

and 25 per cent of the factory staffs perceived for headache as the consequence of air pollution. In non polluted area of Perur, 92 percentage of the office staffs and 78 percentage of the factory staffs had perceived for the headache as the consequence of air pollution. In total, 62.17 percentage of the respondents had perceived for headache as the consequence of air pollution, in polluted area. In non polluted area, 85 percentage had perceived for the headache as the consequence of air pollution.

4.11.2. PERCEPTION OF RESPONDENTS FOR EYE/NOSE/THROAT IRRITATION AS THE CONSEQUENCE OF AIR POLLUTION

The eye/nose/throat irritation was mentioned as one of the impact of air pollution on health. The perception of respondents are shown in table – 31.

TABLE – 31

PERCEPTION OF RESPONDENTS FOR EYE/NOSE/THROAT IRRITATION AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS			YES	NO
	YES	NO	TOTAL	YES	NO	TOTAL		
Polluted:								
Town hall	86	14	100	46	54	100	45.5	54.5
Gandhipuram	25	75	100	16	84	100		
Ukkadam	75	25	100	25	75	100		
Non Polluted:								
Perur	30	70	100	16	84	100	23	77
Total	57	43	100	46.2	53.8	100		

Source: Estimated from the field survey, 2015 – 16.

In air polluted area of Town hall, 86 percentage of the office staffs had perceived for eye/nose/throat irritation as the consequence of air pollution. In the same area, 46 percentage of the factory staffs had perceived for the same health problem. In Gandhipuram, the same health problem was mentioned as the consequence of air pollution by 25 percentage of the office staffs and 16 percentage of the factory staffs. In Ukkadam, 75 percentage of the office staffs and 25 percentage of factory staffs had perceived the above health problem as the consequence of air pollution. In non polluted area, 30 and less than 30 percentage of the respondents had perceived for eye, nose and throat irritation. In total, higher percentage of the respondents had perceived for the above health problem in polluted area than the respondents in non polluted area.

4.11.3. PERCEPTION OF RESPONDENTS FOR RUNNING NOSE AS THE CONSEQUENCE OF AIR POLLUTION

Running nose was perceived as one of the health problem due to air pollution in the study area. The perception of the respondents is shown in table – 32.

TABLE –32

PERCEPTION OF RESPONDENTS FOR RUNNING NOSE AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS			YES	NO
	YES	NO	TOTAL	YES	NO	TOTAL		
Polluted: Town hall	43	57	100	51	49	100	35.8	64.2
Gandhipuram	12.5	87.5	100	8.3	91.7	100		
Ukkadam	75	25	100	25	75	100		
Non Polluted: Perur	69	31	100	51.4	48.6	100	60.2	39.8
Total	46.4	53.6	100	37.5	62.5	100		

Source: Estimated from the field survey, 2015 – 16.

In Town hall, 43 percentage of the office staffs and 51 percentage of the factory staffs had perceived for the running nose as the consequence of air pollution in the study area. In Gandhipuram, only 12.5 percentage of the office staffs and 8.3 per cent of the factory staffs had perceived for running nose as the consequences of air pollution. In Ukkadam, 75 percentage of the office staffs and 25 percentage of factory staffs had perceived for running nose as the consequence of air pollution. In non polluted area of Perur, 69 percentage of the office staffs and 51.4 percentage of the factory staffs had perceived for running nose as the consequence of air pollution. In total, 60.2 percentage of the respondents in non polluted area and 35.8 percentage of the respondents in polluted area had perceived for running nose as the consequence of air pollution.

4.11.4. PERCEPTION OF RESPONDENTS FOR FLU FEVER AS THE CONSEQUENCE OF AIR POLLUTION

Flu fever was perceived as one of the health consequence of air pollution. Hence the perception of the respondents are shown in table – 33.

TABLE – 33
PERCEPTION OF RESPONDENTS FOR FLU FEVER AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS			YES	NO
	YES	NO	TOTAL	YES	NO	TOTAL		
Polluted: Town hall	14.3	85.7	100	38.5	61.5	100	44.92	55.08
Gandhipuram	75	25	100	41.7	58.3	100		
Ukkadam	75	25	100	25	75	100		
Non Polluted: Perur	39	61	100	62.2	37.8	100	50.6	49.4
Total	43	57	100	48.6	51.4	100		

Source: Estimated from the field survey, 2015 – 16.

The highest percentage of the office staffs (75 percentage) in Gandhipuram and Ukkadam had responded for the flu fever as the consequence of air pollution in polluted area. In non polluted area of Perur, 39 percentage of the office staffs and 62.2 percentage of the factory staffs had perceived for the flu fever as the consequence of air pollution. In total, the highest percentage of the respondents in non polluted area had perceived for flu fever as the consequence of air pollution compared to polluted area.

4.11.5. PERCEPTION OF RESPONDENTS FOR SKIN INFECTION/RASH AS THE CONSEQUENCE OF AIR POLLUTION

The perception of office and factory staffs for the skin infection as the consequence of air pollution is given in table – 34.

TABLE – 34
PERCEPTION OF RESPONDENTS FOR SKIN INFECTION/RASH AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS			YES	NO
	YES	NO	TOTAL	YES	NO	TOTAL		
Polluted: Town hall	100	0	100	100	0	100	83.33	16.67
Gandhipuram	100	0	100	100	0	100		
Ukkadam	75	25	100	25	75	100		
Non Polluted: Perur	85	15	100	84	16	100	84.5	15.5
Total	93	7	100	92	8	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall and Gandhipuram, all the 100 percentage of the office and factory staffs had perceived for the skin infection/rash. In Ukkadam, 75

percentage of the office staffs and 25 percentage of the factory staffs had perceived for skin infection/rash. In non polluted area of Perur, 85 percentage of the office staffs and 84 percentage of the factory staffs had perceived for skin infection/rash. In total, higher percentage of the respondents in non polluted area had perceived for skin infection compared to polluted area.

4.11.6. PERCEPTION OF RESPONDENTS FOR ASTHUMA ATTACKS AS THE CONSEQUENCE OF AIR POLLUTION

The perception of respondents for the asthma as the consequence of air pollution is shown in table – 35.

TABLE – 35

PERCEPTION OF RESPONDENTS FOR ASTHUMA ATTACKS AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS			YES	NO
	YES	NO	TOTAL	YES	NO	TOTAL		
Polluted:								
Town hall	86	14	100	100	0	100		
Gandhipuram	100	0	100	100	0	100	81	19
Ukkadam	75	25	100	25	75	100		
Non Polluted:								
Perur	62	38	100	65	35	100	63.5	36.5
Total	78	22	100	81	19	100		

Source: Estimated from the field survey, 2015 – 16.

In non polluted area of Perur, 62 percentage of the office staffs and 65 per cent of the factory staffs had perceived for asthma as the consequence of air pollution. In polluted area of Town hall, 86 percentage of the office staffs and 100 per cent of the factory staffs had perceived for asthma as the consequences of air pollution. In Gandhipuram, all the 100 per cent of the office and factory staffs had perceived for asthma. In Ukkadam, 75 percentage of the office staffs and 25 percentage of the factory staffs had perceived for the asthma as the consequence of air pollution. In total, higher percentage of the respondents in polluted area had perceived for asthma compared to non polluted area.

4.11.7. PERCEPTION OF RESPONDENTS FOR SHORTNESS OF BREATH AS THE CONSEQUENCE OF AIR POLLUTION

Shortness of breath was observed as one of the consequence of air pollution. Hence, the perception of respondents were asked about shortness of breath as the consequence of air pollution. The perception of the perceived is shown in table – 36.

TABLE – 36

PERCEPTION OF RESPONDENTS FOR SHORTNESS OF BREATH AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS			YES	NO
	YES	NO	TOTAL	YES	NO	TOTAL		
Polluted: Town hall	29	71	100	69.2	30.8	100	64.37	35.63
Gandhipuram	88	12	100	100	0	100		
Ukkadam	75	25	100	25	75	100		
Non Polluted: Perur	46.2	53.8	100	27	73	100	36.6	63.4
Total	54	46	100	50	50	100		

Source: Estimated from the field survey, 2015 – 16.

In the polluted area of Town hall, 29 percentage of the office staffs and 69.2 percentage of the factory staffs had perceived for the shortness of breath as the consequence of air pollution. In Gandhipuram, 88 percentage of the office staffs and 100 per cent of the factory staffs had perceived for the shortness of breath as the consequences of air pollution. In Ukkadam, 75 percentage of the office staffs and 25 percentage of the factory staffs had perceived for the shortness of breath as the consequences of air pollution. In non polluted area of Perur, 46.2 percentage of the office staffs and 27 percentage of the factory staffs had responded for the same consequence. In total, higher percentage of the respondents in polluted area had perceived for shortness of breath as the consequence of air pollution compared to non polluted area.

4.11.8. PERCEPTION OF RESPONDENTS FOR DRY SCRATCHY THROAT AS THE CONSEQUENCE OF AIR POLLUTION

The perception of the respondents for dry scratchy throat as the consequence of air pollution is shown in table – 37.

TABLE – 37

PERCEPTION OF RESPONDENTS FOR DRY SCRATCHY THROAT AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS			YES	NO
	YES	NO	TOTAL	YES	NO	TOTAL		
Polluted: Town hall	29	71	100	39	61	100	51.67	48.33
Gandhipuram	50	50	100	92	8	100		
Ukkadam	75	25	100	25	75	100		
Non Polluted: Perur	75	25	100	21.6	78.4	100	48.3	51.7
Total	32.1	67.9	100	40	60	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, 29 percentage of the office staffs and 39 percentage of the factory staffs had perceived for the dry scratchy throat as the consequence of air pollution. In Gandhipuram, the same consequence was perceived by 50 percentage of the office staffs and 92 percentage of the factory staffs. In Ukkadam, 75 percentage of the office staffs and 25 percentage of the factory staffs had perceived for dry scratchy throat as the consequence of air pollution. In non polluted area of Perur, 75 percentage of office staffs and 21.6 percentage of factory staffs had perceived for dry scratchy throat as the consequence of air pollution. In total higher percentage of the responses were found for dry scratchy throat as the consequence of air pollution in polluted area than in non polluted area.

4.11.9. PERCEPTION OF RESPONDENTS FOR CHEST PAIN AS THE CONSEQUENCE OF AIR POLLUTION

Chest pain was also revealed as one of the consequence of air pollution. The perception of the respondents for chest pain as one of the consequence of air pollution is shown in table – 38.

TABLE – 38

PERCEPTION OF RESPONDENTS FOR CHEST PAIN AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS			YES	NO
	YES	NO	TOTAL	YES	NO	TOTAL		
Polluted: Town hall	15	85	100	23	77	100	28.55	71.45
Gandhipuram	25	75	100	8.3	91.7	100		
Ukkadam	75	25	100	25	75	100		
Non Polluted: Perur	15	85	100	28	72	100	21.5	78.5
Total	18	82	100	25	75	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, 15 percentage of the office staffs and 23 percentage of the factory staffs had perceived for chest pain as one of the consequence of air pollution. In Gandhipuram and Ukkadam, the responses were ranged between 8.3 percentage and 75 percentage. In Perur, the same health problem was perceived by respondents of 15 - 28 percentage among office and factory staffs. In total, higher percentage of the respondents in polluted area had perceived for chest pain as the consequence of air pollution than in non polluted area.

4.11.10. PERCEPTION OF RESPONDENTS FOR COUGH WITH PHLEGM AS THE CONSEQUENCE OF AIR POLLUTION

The perception of the respondents pertaining to cough with phlegm is shown in table- 39.

TABLE – 39

PERCEPTION OF RESPONDENTS FOR COUGH WITH PHLEGM AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS			YES	NO
	YES	NO	TOTAL	YES	NO	TOTAL		
Polluted: Town hall	0	100	100	0	100	100	0	100
Gandhipuram	0	100	100	0	100	100		
Ukkadam	0	100	100	0	100	100		
Non Polluted: Perur	0	100	100	19	81	100	9.5	90.5
Total	0	100	100	10	90	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, Gandhipuram and Ukkadam, none of the respondents had perceived for cough with phlegm as the consequence of air pollution. In non polluted area of Perur, only 19 percentage of the factory staffs had perceived for the cough with phlegm as the consequence of air pollution. In total, higher percentage of respondents in non polluted area had perceived for cough with phlegm as the consequence of air pollution compared to polluted area.

4.11.11. PERCEPTION OF RESPONDENTS FOR DRY COUGH AS THE CONSEQUENCE OF AIR POLLUTION

The perception of the respondents pertaining to dry cough as the consequence of air pollution is shown in table – 40.

TABLE – 40

PERCEPTION OF RESPONDENTS FOR DRY COUGH AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted:								
Town hall	72	28	100	61.5	38.5	100		
Gandhipuram	85	15	100	91.7	8.3	100	68.37	31.63
Ukkadam	75	25	100	25	75	100		
Non Polluted:								
Perur	77	23	100	51.4	48.6	100	64.2	35.8
Total	79	21	100	60	40	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, 72 percentage of the office staffs and 61.5 percentage of the factory staffs had perceived for the dry cough as the consequence of air pollution. In Gandhipuram, 85 percentage of the office staffs and 91.7 percentage of the factory staffs had perceived for the dry cough as the consequence of air pollution. In Ukkadam, 75 percentage of the office staffs and 25 percentage of the factory staffs had perceived for the dry cough as the consequence of air pollution. In non polluted area of Perur, 77 percentage of the office staffs and 51.4 percentage of the factory staffs had perceived for the dry cough as the consequence of air pollution. In total, higher percentage of the respondents in polluted area had perceived for dry cough as the consequence of air pollution than in non polluted area.

4.11.12. PERCEPTION OF RESPONDENTS FOR BRONCHITIS AS THE CONSEQUENCE OF AIR POLLUTION

The perception of respondents pertaining to bronchitis as the consequence of air pollution is shown in table – 41.

TABLE - 41

PERCEPTION OF RESPONDENTS FOR BRONCHITIS AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted:								
Town hall	15	85	100	15	85	100		
Gandhipuram	0	100	100	15	85	100	24.17	75.83
Ukkadam	75	25	100	25	75	100		
Non Polluted:								
Perur	0	100	100	2.7	97.3	100	1.35	98.65
Total	3.6	96.4	100	5.6	94.4	100		

Source: Estimated from the field survey, 2015 – 16.

Less percentage of both office and factory staffs in polluted area of Town hall and Gandhipuram had perceived for the bronchitis as the consequence of air pollution. In Ukkadam, 75 percentage of the office staffs and 25 percentage of the factory staffs had perceived for bronchitis as the consequence of air pollution. In total, 24.17 percentage of the respondents had perceived for bronchitis as the consequence of air pollution in polluted area. In non polluted area, only 1.35 percentage of the respondents had perceived for the same type of disease.

4.11.13. PERCEPTION OF RESPONDENTS FOR DROWSINESS AS THE CONSEQUENCE OF AIR POLLUTION

Drowsiness was expected to be one of the consequence of air pollution in the study area. The perception of respondents pertaining to drowsiness is shown in table – 42.

TABLE – 42

PERCEPTION OF RESPONDENTS FOR DROWSINESS AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted:								
Town hall	0	100	100	15	85	100	21.67	78.33
Gandhipuram	15	85	100	0	100	100		
Ukkadam	75	25	100	25	75	100		
Non Polluted:								
Perur	15	85	100	5.4	94.6	100	10.2	89.8
Total	10.7	89.3	100	7	93	100		

Source: Estimated from the field survey, 2015 – 16.

In Town hall, none of the office staffs and 15 percentage of the factory staffs had perceived for drowsiness as the consequence of air pollution. In Gandhipuram, 15 percentage of the office staffs and none of the factory staffs had perceived for drowsiness as the consequence of air pollution. In Ukkadam, 75 percentage of the office staffs and 25 percentage of the factory staffs had perceived for drowsiness as the consequence of air pollution. In total, 21.67 percent of the respondents in polluted area and 10.2 percentage of the respondents in non polluted area had perceived for drowsiness as the consequence of air pollution.

4.11.14. PERCEPTION OF RESPONDENTS FOR PNEUMONIA AS THE CONSEQUENCE OF AIR POLLUTION

The perception of the respondents in polluted and non polluted area were asked for pneumonia as the consequence of air pollution. The perception of the respondents pertaining to pneumonia is shown in table – 43.

TABLE – 43

PERCEPTION OF RESPONDENTS FOR PNEUMONIA AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted:								
Town hall	0	100	100	8	92	100	20.5	79.5
Gandhipuram	15	85	100	0	100	100		
Ukkadam	75	25	100	25	75	100		
Non Polluted:								
Perur	0	100	100	3	97	100	1.5	98.5
Total	7	93	100	5	95	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, none of the office staffs and eight percent of the factory staffs had perceived for pneumonia as the consequence of air pollution. In Gandhipuram, 15 percentage of the office staffs and none of the factory staffs had perceived for pneumonia as the consequence of air pollution. In Ukkadam, 75 percentage of the office staffs and 25 percentage of the factory staffs had perceived for the same disease. In non polluted area of Perur, no responses were found for pneumonia as the consequence of air pollution among office staffs. But among the factory staffs, 3 percentage had responded for the pneumonia as the consequence of air pollution.

In total, 20.5 percentage of the respondents in polluted area and 1.5 percentage of the respondents in non polluted area had perceived for pneumonia as the consequence of air pollution.

4.10.15. PERCEPTION OF RESPONDENTS FOR HEART DISEASES AS THE CONSEQUENCE OF AIR POLLUTION

The perception of the respondents for heart diseases as the consequence of air pollution were asked. The responses are shown in table – 44.

TABLE – 44

PERCEPTION OF RESPONDENTS FOR HEART DISEASES AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted:								
Town hall	29	71	100	8	92	100	52	48
Gandhipuram	100	0	100	100	0	100		
Ukkadam	0	100	100	75	25	100		
Non Polluted:								
Perur	0	100	100	89.2	10.8	100	44.6	55.4
Total	42.9	57.1	100	88.1	11.9	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, 29 percentage of the office staffs and 8 percentage of the factory staffs had perceived for heart diseases as the consequence of air pollution. In Gandhipuram, 100 percentage of the office staffs and 100 percentage of the factory staffs had perceived for heart diseases as the consequence of air pollution. In Ukkadam, none of the office staffs and 75 percentage of the factory staffs had perceived for the heart disease as the consequence of air pollution. In non polluted area of Perur, no response was observed from office staffs and 89.2 percentage of the factory staffs had perceived for heart diseases as the consequence of air pollution. In total, higher percentage of the respondents in polluted area had perceived for heart diseases compared to non polluted area.

4.11.16. PERCEPTION OF RESPONDENTS FOR CANCER AS THE CONSEQUENCE OF AIR POLLUTION

The perception of the respondents for cancer as the consequence of air pollution is shown in table – 45.

TABLE – 45

PERCEPTION OF RESPONDENTS FOR CANCER AS THE CONSEQUENCE OF AIR POLLUTION

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted: Town hall	71.4	28.6	100	31	69	100	47.07	52.93
Gandhipuram	38	62	100	42	58	100		
Ukkadam	75	25	100	25	75	100		
Non Polluted: Perur	31	69	100	46	54	100	38.5	61.5
Total	42.9	57.1	100	43.1	56.9	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, 71.4 percentage of the office staffs and 31 percentage of the factory staffs had perceived for cancer as the consequence of air pollution. In Gandhipuram, 38 percentage of the office staffs and 42 percentage of the factory staffs had perceived for cancer as the consequence of air pollution. In Ukkadam, 75 percentage of the office staffs and 25 percent of factory staffs had perceived for cancer as the consequence of air pollution. In non polluted area of Perur, 31 percentage of the office staffs and 46 percentage of the factory staffs had perceived for cancer as the consequence of air pollution. In total, higher percentage of the respondents in polluted area had perceived for cancer as the consequence of air pollution than in non polluted area.

4.12. FAMILY MEMBERS SUFFERED FROM DISEASES

The table- 46 shows the number of persons suffered from diseases in the study area.

TABLE – 46

FAMILY MEMBERS SUFFERED FROM DISEASES

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted: Town hall	57.1	42.9	100	8	92	100	65.02	34.98
Gandhipuram	75	25	100	100	0	100		
Ukkadam	75	25	100	75	25	100		
Non Polluted: Perur	39	61	100	89.2	10.8	100	64.1	35.9
Total	54.5	45.5	100	61.1	38.9	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, 57.1 percentage of the office staffs families and 8 per cent of the factory staffs families had suffered from diseases. In Gandhipuram, 75 percentage of the office staffs and 100 percentage of the factory staffs had responded for the occurrence of diseases for their family members. In Ukkadam, 75 percentage of the office staffs and factory staffs families had suffered from diseases. In non polluted area of Perur, 39 percentage of the office staffs family members and 89.2 percentage of the factory staffs family members had suffered from diseases. In total, 65.02 percentage of the respondents families in polluted area and 64.1 percentage of the respondents families in non polluted area had suffered from diseases. It revealed that higher percentage of the family members in polluted area had suffered from different diseases than in non polluted area.

4.13. HEALTH PROBLEM EXPENIENCED BY THE RESPONDENTS IN THE STUDY AREA

The following health problems were observed with the respondent's family.

- Fever
- Asthma
- Headache
- Cold

4.13.1. RESPONSES OF THE RESPONDENTS PERTAINING TO OCCURRENCE OF FEVER

The responses of the respondents pertaining to occurrence of fever are shown in table– 47.

TABLE – 47

RESPONSES OF THE RESPONDENTS PERTAINING TO OCCURRENCE OF FEVER

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted: Town hall	20	80	100	39	62	100	40.33	59.67
Gandhipuram	43	57	100	40	60	100		
Ukkadam	25	75	100	75	25	100		
Non Polluted: Perur	80	20	100	26	74	100	53	47
Total	35	65	100	23.4	76.6	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, 20 percentage of the office staffs had fever. In the same area, 39 percentage of the factory staffs had fever. In Gandhipuram, 43 per cent of the office staffs and 40 percentage of the factory staffs had responded for the occurrence of fever. In Ukkadam, 25 per cent of the office staffs and 75 percentage of the factory staffs had stated for the occurred of fever. In non polluted area of Perur, higher percentage of the office staffs had stated for the occurrence of fever than the factory staffs. When both office and factory staffs were analysed together, higher percentage of the respondents in non polluted area had responded for fever compared to polluted area.

4.13.2. THE RESPONSES OF THE RESPONDENTS PERTAINING TO THE OCCURRENCE OF ASTHMA

The responses of the respondents pertaining to the occurrence of asthma and reciprotary diseases are shown in table – 48.

TABLE – 48

THE RESPONSES OF THE RESPONDENTS PERTAINING TO THE OCCURRENCE OF ASTHMA

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted: Town hall	80	20	100	39	61	100	62	38
Gandhipuram	43	57	100	60	40	100		
Ukkadam	75	25	100	75	25	100		
Non Polluted: Perur	83	17	100	26	74	100	54.5	45.5
Total	35	65	100	23.4	76.6	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, 80 percentage of the office staffs and 39 percentage of the factory staffs had stated for the occurrence of Asthma. In Gandhipuram, 43 per cent of the office staffs and 60 percentage of the factory staffs had stated for the occurrence of Asthma. In Ukkadam, 75 percentage of office and factory staffs had stated for the occurrence of Asthma. In non polluted area of Perur, 83 percentage of the office staffs and 26 percentage of the factory staffs had stated for the occurrence of Asthma. In total, 62 percentage of the respondents in polluted area and only 54.5 percentage of the respondents in non polluted area had stated for the occurrence of Asthma.

4.13.3. THE RESPONSES OF THE RESPONDENTS PERTAINING TO THE OCCURRENCE OF HEADACHE

The occurrence of headache in polluted and non polluted area is shown in table – 49.

TABLE – 49

THE RESPONSES OF THE RESPONDENTS PERTAINING TO THE OCCURRENCE OF HEADACHE

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted: Town hall	71	29	100	69	31	100	62.17	37.83
Gandhipuram	75	25	100	58	42	100		
Ukkadam	75	25	100	25	75	100		
Non Polluted: Perur	92	8	100	78	22	100	85	15
Total	54.5	45.5	100	29.2	70.8	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, 71 percentage of the office staffs and 69 percentage of the factory staffs had stated for the occurrence of headache. In Gandhipuram, 75 percentage of the office staffs and 58 percentage of the factory staffs had stated for the occurrence of headache. In Ukkadam, 75 percentage of the office staffs and 25 percentage of the factory staffs had stated for the occurrence of headache. In non polluted area of Perur, 92 percentage of the office staffs and 78 percentage of the factory staffs had opined for the occurrence of headache. In nutshell, 62.17 percentage of the respondents in polluted area and 85 percentage of the respondents in non polluted area had headache.

4.13.4. THE RESPONSES OF THE RESPONDENTS PERTAINING TO THE OCCURRENCE OF COLD

The responses of respondents pertaining to the occurrence of cold are shown in table–50.

TABLE – 50
THE RESPONSES OF THE RESPONDENTS PERTAINING TO THE OCCURRENCE OF COLD

(In Percentage)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted: Town hall	20	80	100	39	61	100	40.33	59.67
Gandhipuram	43	57	100	40	60	100		
Ukkadam	25	75	100	75	25	100		
Non Polluted: Perur	80	20	100	26	74	100	53	47
Total	35	65	100	23.4	76.6	100		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, 20 percentage of the office staffs and 39 percentage of the factory staffs had cold. In Gandhipuram, 43 percentage of office staffs and 40 percentage of the factory staffs had cold. In Ukkadam, 25 percentage of the office staffs and 75 percentage of the factory staffs had cold. In non polluted are of Perur, 80 percentage of the office staffs and 26 percentage of the factory staffs had cold. In total, 40.33 percentage of the respondents in polluted area and 53 percentage of the respondents in non polluted area had cold.

4.14. CONSEQUENCES OF AIR POLLUTION OTHER THAN DISEASES

4.14.1. NUMBER OF DAYS SUFFERED FROM HEALTH PROBLEM

The average number of days suffered from health problem is given in table – 51.

TABLE – 51

NUMBER OF DAYS SUFFERED FROM HEALTH PROBLEM

PLACE	OCCUPATION	MEAN (Days per month)
Polluted: Town hall	Office staffs	4.00
	Factory staffs	3.23
	Total	3.50
Gandhipuram	Office staffs	13.00
	Factory staffs	8.50
	Total	10.30
Ukkadam	Office staffs	3.50
	Factory staffs	3.50
	Total	3.50
Non Polluted: Perur	Office staffs	2.00
	Factory staffs	2.00
	Total	2.00

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, on an average, the respondents had suffered from health problem for 3.5 days per month. In Gandhipuram, the respondents had suffered for 10.3 days per month. In Ukkadam, they had suffered on an average 3.5 days per month. In non polluted area of Perur, the respondents had suffered from health problem for 2 days per month.

4.14.2. HOSPITAL VISITS:

The average number of days visited to the hospital was calculated and is shown in table – 52.

TABLE – 52

HOSPITAL VISITS

PLACE	OCCUPATION	MEAN (In times per month)
Polluted: Town hall	Office staffs	2
	Factory staffs	2
	Total	2
Gandhipuram	Office staffs	2
	Factory staffs	2
	Total	2
Ukkadam	Office staffs	2
	Factory staffs	2
	Total	2
Non Polluted: Perur	Office staffs	1
	Factory staffs	1
	Total	1

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, Gandhipuram and Ukkadam, the respondents had visited the hospitals two times per month. But in non polluted area of Perur, they had visited the hospitals one time per month.

4.14.3. VISITING DOCTOR

The average number of times visiting the doctor per month was calculated and is shown in table – 53.

TABLE – 53

VISITING DOCTOR

PLACE	OCCUPATION	MEAN (In times per month)
Polluted: Town hall	Office staffs	2
	Factory staffs	2
	Total	2
Gandhipuram	Office staffs	2
	Factory staffs	2
	Total	2
Ukkadam	Office staffs	2
	Factory staffs	2
	Total	2
Non Polluted: Perur	Office staffs	1
	Factory staffs	1
	Total	1

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, Gandhipuram, and Ukkadam, on an average, the family members of the respondents had visited the doctor two times per month for consulting their health problem. In non polluted area of Perur, the family members of the respondents had visited doctors one time per month to consult their health problem.

4.14.4. MEDICAL EXPENSES:

Average medical expenses of family members of respondents in polluted and non polluted area are shown in table – 54.

TABLE – 54

MEDICAL EXPENSES

PLACE	OCCUPATION	MEAN (In Rs. per month)
Polluted: Town hall	Office staffs	100.00
	Factory staffs	153.85
	Total	135.00
Gandhipuram	Office staffs	212.50
	Factory staffs	208.33
	Total	210.00
Ukkadam	Office staffs	90.00
	Factory staffs	90.00
	Total	90.00
Non Polluted: Perur	Office staffs	90.00
	Factory staffs	90.00
	Total	90.00

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, the office staffs had incurred an average amount of Rs.100 per month and factory staffs Rs.153.85 per month. In Gandhipuram, the office staffs had incurred Rs.212.50 per month and the factory staffs Rs.208.33 per month. In Ukkadam, office and factory staffs had incurred Rs.90 per month. In non polluted area of Perur, office and factory staffs had incurred Rs.90 per month as the medical expenses.

4.14.5. NUMBER OF WORKING DAYS LOST FOR OFFICE

The number of working days lost per month for office due to ill health was calculated and discussed.

TABLE – 55

LEAVE FOR OFFICE WORK

PLACE	OCCUPATION	MEAN (In days per month)
Polluted: Town hall	Office staffs	1.71
	Factory staffs	1.08
	Total	1.30
Gandhipuram	Office staffs	1.25
	Factory staffs	1.00
	Total	1.10
Ukkadam	Office staffs	0.00
	Factory staffs	0.00
	Total	0.00
Non Polluted: Perur	Office staffs	0.77
	Factory staffs	0.62
	Total	0.40

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, on an average, the office staffs had taken leave for two days per month. The same for factory staffs was one day per month. In Gandhipuram, office staffs put leave for 1.25 days per month due to illness. The same was one day per month for factory staffs. In Ukkadam, both office and factory staffs did not put leave due to illness. In non polluted area, both office and factory staffs had taken leave of less than one day per month.

4.14.6. LEAVE FOR HOUSEHOLD WORK

The respondents expressed that due to illness, they were not able to perform their household work. The responses of the respondents pertaining to their absence in the household work are shown in table – 56.

TABLE – 56

LEAVE FOR HOUSEHOLD WORK

PLACE	OCCUPATION	MEAN (In days per month)
Polluted: Town hall	Office staffs	1
	Factory staffs	1
	Total	1
Gandhipuram	Office staffs	1
	Factory staffs	1
	Total	1
Ukkadam	Office staffs	1
	Factory staffs	1
	Total	1
Non Polluted: Perur	Office staffs	0
	Factory staffs	0
	Total	0

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, Gandhipuram and Ukkadam, the mean days absent per month for household work was one day. In non polluted area of Perur, they did not absent for household work. All the respondents were able to perform their household work without absent, in non polluted area.

4.14.7. LOSS OF INCOME DUE TO ILLNESS

Loss of income due to illness was responded by the respondents. The average loss of income due to illness is shown in table – 57.

TABLE – 57

LOSS OF INCOME DUE TO ILLNESS

PLACE	OCCUPATION	MEAN (In Rs. per month)
Polluted: Town hall	Office staffs	2000
	Factory staffs	4300
	Total	2650
Gandhipuram	Office staffs	2500
	Factory staffs	3000
	Total	2750
Ukkadam	Office staffs	1000
	Factory staffs	1000
	Total	1000
Non Polluted: Perur	Office staffs	1000
	Factory staffs	1000
	Total	1000

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, the loss of income was Rs.2000 per month for office staffs and Rs.4300 per month for factory staffs. In Gandhipuram, the loss of income was Rs.2500 per month for office staffs and Rs.3000 per month for factory staffs. In Ukkadam, the average loss of income was Rs.1000 per month for office and factory staffs. In non polluted area of Perur, the average amount of income loss was Rs.1000 per month for office and factory staffs. It showed that higher amount of income loss was found in polluted area than in non polluted area due to health issues.

4.14.8. NUMBER OF DEATHS IN THE FAMILY

Number of deaths in the family due to illness in polluted and non polluted area are shown in table – 58.

TABLE – 58

NUMBER OF DEATHS IN THE FAMILY

(In Number)

PLACE	OCCUPATION						TOTAL	
	OFFICE STAFFS			FACTORY STAFFS				
	YES	NO	TOTAL	YES	NO	TOTAL	YES	NO
Polluted:								
Town hall	4	3	7	6	7	13		
Gandhipuram	4	4	8	8	4	12	22	18
Ukkadam	0	0	0	0	0	0		
Non Polluted:								
Perur	0	0	0	0	0	0	0	0
Total	8	7	15	14	11	25		

Source: Estimated from the field survey, 2015 – 16.

In polluted area of Town hall, office staffs had stated that 4 persons had died due to illness in the year 2015-2016 in their own family. Similarly, the factory staffs had responded that number of deaths in the respondents own family were 6 due to illness in the year 2015 -2016. In Gandhipuram, 4 persons and 8 persons were died in the family of office staffs and factory staffs due to illness. In Ukkadam, none of the deaths were found in the respondents family due to illness. In non polluted area of Perur, the respondents of both office and factory staffs had stated no deaths in their own family. In total, higher number of deaths were occurred in polluted area than in non polluted area.

4.14.9. AGE AT THE TIME OF DEATH

Average age of deaths in the respondents family was calculated and is shown in table – 59.

TABLE – 59

AGE AT THE TIME OF DEATH

PLACE	OCCUPATION	MEAN (In Year)
Polluted:	Office staffs	59.00
Town hall	Factory staffs	70.57
	Total	67.10
	Office staffs	68.14
Gandhipuram	Factory staffs	64.67
	Total	67.10
	Office staffs	0
Ukkadam	Factory staffs	0
	Total	0
Non Polluted:	Office staffs	0
Perur	Factory staffs	0
	Total	0

Source: Estimated from the field survey, 2015 – 16.

The average age of death in the office staffs family in Town hall was 59 years. In Town hall, in the families of factory staffs, the average age of death was 70.57 years. In polluted area of Gandhipuram, the average age of death in the families of office staffs was 68.14 years. The same was 64.67 years in the families of factory staffs in Gandhipuram. In Ukkadam, there were no deaths in the respondents families in the year 2015-2016. In the non polluted area of Perur also, no death was observed in the respondents family.

4.15. ASSOCIATION BETWEEN THE AIR POLLUTION AND PERCEPTION OF HEALTH PROBLEM

To assess the association between the air pollution and perception of health problem by the respondents due to air pollution such as headache, eye/nose/throat irritation, running nose/ cold, flu/fever, skin infection/rash, asthma attacks, shortness of breath, respiration allergy to dust and pollen, dry scratchy throat, chest pain, cough with phlegm, dry cough, bronchitis, drowsiness, pneumonia, heart disease and cancer, the chi square test was employed. The results of chi square test are shown in table – 60.

TABLE – 60

ASSOCIATION BETWEEN THE AIR POLLUTION AND PERCEPTION OF HEALTH PROBLEM

S.NO	VARIABLES	CHI – SQUARE VALUE	LEVEL OF SIGNIFICANCE
1	Headache	3.326	In significant
2	Eye/nose/throat irritation	7.644	Significant at 5 % level
3	Running nose/cold	4.31	In significant
4	Flu/ fever	3.252	In significant
5	Skin infection/ rash	2.751	In significant
6	Asthma attacks	16.000	Significant at 5 % level
7	Shortness of Breadth	14.446	Significant at 5 % level
8	Dry scratchy throat	10.866	Significant at 5 % level
9	Cheat Pain	.508	In significant
10	Cough with phlegm	3.2	In significant
11	Dry cough	2.154	In significant
12	Bronchitis	1.895	In significant
13	Drowsiness	1.011	In significant
14	Pneumonia	2.011	In significant
15	Heart Disease	.444	In significant
16	Cancer	.041	In significant

Source: Estimated from the field survey, 2015 – 16.

In the chi square analysis, the variables such as eye/nose/throat irritation, asthma attacks, shortness of breath and dry scratchy throat were statistically significant. The hypothesis of no association between air pollution and the above diseases was rejected. It implied that the respondents in polluted area perceived eye/ nose/throat irritation, asthma attacks, shortness of breath and dry scratchy throat as the consequences of air pollution. It indicated that the air pollution had caused significantly the above diseases. The variables such as headache, running nose/cold, flu fever, skin infection/rash, chest pain, dry cough, bronchitis, drowsiness, pneumonia, heart disease and cancer were statistically insignificant. It implied that there was no significant association between the air pollution and perception of above diseases by the respondents.

4.16. ASSOCIATION BETWEEN THE AIR POLLUTION AND HEALTH INDICATORS IN THE STUDY AREA –CHI SQUARE TEST

To assess the association between the air pollution and the health indicators such as days of sick, age of death, number of deaths in the family, number of times visited the doctors, number of times visited hospital, expenditure on medicine, health problem experienced such as the fever, asthma and respiratory diseases, headache and cold, chi square test was applied. The results of chi square test are given in table – 61.

TABLE – 61

ASSOCIATION BETWEEN THE AIR POLLUTION AND HEALTH INDICATORS IN THE STUDY AREA –CHI SQUARE TEST

S.NO.	VARIABLES	CHI-SQUARE	LEVEL OF SIGNIFICANCE
1	Days of sick	25.333	Significant
2	Age of death	34.238	Significant
3	Number of deaths in the family	7.429	Significant
4	Number of times visited the doctors	4.576	In significant
5	Number of times hospital visiting	5.282	Insignificant
6	Expenses on medicine	8.629	In significant
7	Fever	0.042	In significant
8	Asthma/ respiratory diseases	5.429	Significant
9	Headache	3.175	In significant
10	Cold	1.654	In significant

Source: Estimated from the field survey, 2015 – 16.

The results showed that the estimated chi square value was statistically significant for the variables such as days of sick, age of death, number of deaths in the family, asthma and respiratory diseases. The null hypothesis of no association between the above stated variables and air pollution was rejected. Hence the alternate hypothesis of association between air pollution and days of sick, age of death, number of deaths in the family, asthma and respiratory diseases was accepted. It revealed that there was strong association between air pollution and days of sick, age at death, number of deaths in the family, asthma and respiratory diseases. The value of chi square pertaining to the variables such as number of times visiting the doctors, number of times visiting the hospital, expenses on medicine, occurrence of fever, headache and cold were statistically in significant. It implied that there was no association between the above stated variables and the air pollution.

CHAPTER V

SUMMARY AND CONCLUSION

The air quality is measured based on three components such as the nitrogen oxide, sulphur oxide and PM_{10}. In India, the level of nitrogen oxide and sulphur oxide were in the prescribed level while the level of PM_{10} was not within the level. The data available from the Central Pollution Control Board (CPCB) indicate that the levels of small particles less than 10 micron (PM_{10}) are very high. This size of particulates is known to cause severe damage to the lungs. In fact, the World Health Organization (WHO) reports that there is no safe level for particulate matter emissions, international studies have confirmed association between elevated levels of particulate matter air pollution and decline in lung function or increase in respiratory symptoms such as cough, shortness of breath, wheezing and asthma attacks. Studies have also found associations between particulate matter air pollution and rates of hospitalization, chronic obstructive pulmonary disease and restricted activity due to illness (Dockery, 1993). In this backdrop, earlier studies had attempted to assess the impact of air pollution on health at macro level. The studies on the impact of air pollution on health at micro level were rare. Hence, an attempt was made to assess the impact of air pollution on health in Coimbatore city.

The following are the specific objectives of the study.

1. To analyse the trend in the air quality in Coimbatore city.
2. To assess the socio economic profile of selected households.
3. To identify the determinants of air pollution.
4. To study the association between the air pollution and health.

The following hypotheses were tested to fulfill the objectives.

1. The air pollution was independent from the selected socio – economic and pollution related factors.
2. There was no association between the air pollution and the health problem.

METHODOLOGY

Growth of vehicles is one of the major causes of air pollution. The earlier studies had proved that the cities with high number of cars had attributed to more air pollution particularly to higher level of particulate matter. The PM_{10} concentration was higher in the cities of higher average number of cars. The world Health Organization had conducted a study which showed that Coimbatore was one of the city with high number of motor

vehicles. The number of motor vehicles in the city was more than the national average. The study stated that the high number of vehicles in Coimbatore had caused to increase the level of PM_{10} above the standard limit. The high level of PM_{10} caused health problem. Hence Coimbatore city was selected for the study. The data for the study were collected from both primary and secondary sources. For collecting primary data, the sampling technique adopted in the study was multi stage random sampling technique. In the Coimbatore city, from the polluted area such as Town hall, Gandhipuram and Ukkadam, 50 respondents were identified randomly and selected to assess the views about the impact of air pollution on health. From the non polluted area of Perur, another 50 respondents were selected randomly. Hence the total sample size was one hundred. The primary data were collected from the hundred respondents based on personal interview method by administering pre tested interview schedule. The survey was conducted in the months of December, 2015 and January, 2016. The secondary data on trends in air quality in Coimbatore city were collected from the Air Pollution Data Base of Tamil Nadu, 2014, the Department of Environment, Government of Tamil Nadu and Pollution Control Board, Tamil Nadu. The logistic regression analysis was employed to assess the determinants of air pollution. The chi square test was used to assess the association between the air pollution and health impact in the study area. Simple percentages and averages were also used along with the above econometric tools.

The major findings of the study are as under

I. RESULTS BASED ON SECONDARY DATA

1. TRENDS IN AMBIENT AIR QUALITY IN TOWN HALL AND UKKADAM (2003 - 2012)

The level of total suspended particulate matter (TSPM) in Town hall and Ukkadam was ranged between 86 $\mu g/m^3$ and 113 $\mu g/m^3$ in the period 2003 – 2004 and 2010 – 2011. The level of respirable suspended particulate matter (RSPM) had varied between 44 $\mu g/m^3$ and 68 $\mu g/m^3$ in the period of 2003 – 2004 and 2011 – 2012 in the above places. The value of respirable suspended particulate matter (RSPM) had exceeded the prescribed level in Town hall and Ukkadam in 2012. The value of nitrogen oxide and sulfur dioxide had declined in the period of 2003 – 2004 and 2011 – 2012. The value of nitrogen oxide had declined from 46 µg/m3 in 2003-2004 to 29$\mu g/m^3$ in 2012. It had exceeded the standard limit in the period 2003 – 2005. The value of sulfur dioxide had declined from 10 $\mu g/m^3$ in 2003 – 2004 to 5 $\mu g/m^3$ in 2012. The above trends revealed that respirable suspended

particulate matter (RSPM) and nitrogen oxide were the major pollutants of air in Town hall and Ukkadam in the time period of 2003 -2012.

2. TRENDS IN AMBIENT AIR QUALITY IN GANDHIPURAM IN COIMBATORE

The level of total suspended particulate matter (TSPM) had shown fluctuating trend in the period 2003 – 2012. It had increased from 108 $\mu g/m^3$ in 2003 – 2004 to 157 $\mu g/m^3$ in 2010 – 2011. Similarly respirable suspended particulate matter (RSPM) had also shown fluctuating trend. It had increased from 43 $\mu g/m^3$ in 2003 – 2004 to 68 µg/m3 in 2011 – 2012. But nitrogen oxide and sulfur dioxide had declined in the period of 2003 – 2012. The level of total suspended particulate matter (TSPM) and respirable suspended particulate matter (RSPM) had exceeded the prescribed level in 2010 – 2011 and in 2011 – 2012 respectively. The level of nitrogen oxide was within the prescribed level in all the time periods except during the year 2003 – 2004 and 2005 – 2006. The level of sulfur dioxide was within the prescribed limit in all the time period. It showed that total suspended particulate matter (TSPM) and respirable suspended particulate matter (RSPM) were the important pollutants of air in Gandhipuram along with nitrogen oxide.

3. TRENDS IN AMBIENT AIR QUALITY IN THE INDUSTRIAL AREA OF COIMBATORE DISTRICT

The total suspended particulate matter (TSPM) and respirable suspended particulate matter (RSPM) had increased in the period from 2003 – 2004 to 2011 – 2012. The level of total suspended particulate matter (TSPM) and respirable suspended particulate matter (RSPM) exceeded the prescribed limit in all the time period. The level of nitrogen oxide and sulfur dioxide had declined. The major pollutants of air were total suspended particulate matter and respirable suspended particulate matter (RSPM) along with nitrogen oxide in the industrial area of Coimbatore.

4. AIR QUALITY IN RESIDENTIAL ZONE OF COIMBATORE, 2014-2015

The air quality was estimated in residential zone of Anna nagar, Sowripalayam, Ganapathy, Saibaba colony and Ram nagar in Coimbatore. The lower limit of Suspended Particulate Matter (SPM) was higher in Ram nagar. The upper limit of Suspended Particulate Matter was higher in Anna nagar. In all the residential areas, the level of Sulfur dioxide and Nitrogen oxide did not exceed the minimum level prescribed by the pollution control board.

5. AIR QUALITY IN COMMERCIAL ZONE OF COIMBATORE, 2014 – 2015

The very important commercial zones observed in Coimbatore were R.S.Puram, Gandhipuram, Peelamedu, Town hall, and Ukkadam. In these areas, the pollution control board took sample and had calculated the air quality index. The highest level of suspended particulate matter (SPM) was observed in Ukkadam compared to other commercial areas. It was ranged between 953.36 – 984.54. It had exceeded the prescribed limit of pollution control board. In all the selected commercial area, the level of suspended particulate matter (SPM) had exceeded the prescribed limit of pollution control board. The level of Sulfur dioxide and Nitrogen oxide were within the prescribed limit in all the commercial parts.

6. AIR QUALITY IN INDUSTRIAL ZONE OF COIMBATORE 2014 – 2015

It was found that the level of suspended particulate matter (SPM) in all the industrial areas exceeded the prescribed limit. The level of Sulfur dioxide and Nitrogen oxide were highest in Foundry Unit and Cement Factory Unit respectively. But the level was within the prescribed limit in the above stated areas and in other industrial parts.

II RESULTS BASED ON PRIMARY DATA

7. AVERAGE NUMBER OF YEARS OF STAYING BY THE RESPONDENTS IN THE STUDY AREA

In polluted area, in Ukkadam, the respondents had stayed for 18 years. It was higher than the average number of years of staying of respondents in other places of polluted area. In non polluted area, the mean year of staying by the respondents was around 17 years.

8. SOCIO ECONOMIC PROFILE OF RESPONDENTS IN POLLUTED AND NON-POLLUTED AREA

AGE OF THE RESPONDENTS

In polluted area, in Town hall, the mean age of office staff was 35 years and factory staffs was 30 years. In Gandhipuram and Ukkadam, the mean age of the respondents was ranged between 27 to 33 years. In non polluted area of Perur, the mean age of office and factory staffs was same as around 35 years.

SIZE OF FAMILY

In polluted area, the average size of family was on an around 4 for both office and factory staffs. In non polluted area, in Perur, the mean size of family was on an around 5. It showed that the size of family was larger in non polluted area than in polluted area.

INCOME OF THE HOUSEHOLD

In polluted area of Town hall, the average monthly income of the factory staffs was higher than the office staffs. In Gandhipuram, the average monthly income of office staffs was higher than the factory staffs. In Ukkadam, there was no difference in the monthly income of the households between factory and office staffs. In non polluted area, in Perur, the average monthly family income of factory staffs was higher than the office staffs.

PATTERN OF HOUSE

It was found that in both polluted and non polluted area, all the 100 per cent of the households had pacca houses. None of the household was living in kacha house. It revealed better economic position of the household.

9. CAUSES OF AIR POLLUTION

EXISTENCE OF SEPARATE KITCHEN

In both polluted and non polluted area, all the 100 percentage of the respondents had stated for the separate kitchen at home. Hence the existence of no separate kitchen was not a major factor causing air pollution in the study area.

ENERGY CONSUMPTION EXPENDITURE FOR COOKING

The mean consumption expenditure for cooking in polluted area was Rs.680 per month. In non polluted area, the average monthly expense on energy consumption for cooking was Rs.689 for office staffs and Rs.680 for factory staffs. It showed that there was no much variation in the average expenses on energy consumption between polluted and non polluted area.

NUMBER OF TIMES COOKING PER DAY

In polluted area of Town hall and Gandhipuram, the average number of times cooking per day was three while it was two in Ukkadam. In non polluted area of Perur, the average number of times cooking per day was only two for both office and factory staffs. Hence, it revealed that the average number of times cooking per day was higher in polluted area than in non polluted area.

AVERAGE HOURS OF COOKING PER DAY

In polluted places of Town hall, Gandhipuram and Ukkadam, the average hours of cooking was 2 hours per day. In non polluted place of Perur also, the hours of cooking was only two hours per day. It showed that there was no difference in the cooking hours per day between polluted and non polluted area.

MONTHLY AVERAGE ELECTRICITY CONSUMPTION EXPENDITURE

In Town hall, the average monthly electricity consumption expenditure was Rs.729 for office staffs and Rs.731 for factory staffs. Similarly in Gandhipuram, it was ranged between Rs.592 and Rs.644. In Ukkadam, it was only Rs.470. In Perur, it was ranged between Rs.570 and Rs.692.

USING OF AIR CONDITIONER

In polluted area of Town hall, 57.1 percentage of the office staff and 46 percentage of the factory staffs had used air conditioner at home. In Gandhipuram, more than 50 percentage of the respondents had used air conditioner. In Ukkadam, none of the office and factory staffs had used air conditioner. In non polluted area also, none of the respondents had used air conditioner. In total, higher percentage of respondents had used air conditioner in polluted area compared to other area.

USING OF HEATER

None of the respondents had used heater during the winter in both polluted and non polluted areas.

USING OF EXHAUST FAN

In polluted area of Town hall, 100 percentage of the office staffs and 69 percentage of the factory staffs had used exhaust fan at home. In Gandhipuram, more than 50 percentage of the respondents had used exhaust fan. In Ukkadam, 25 percentage of the office and factory staffs had used exhaust fan. In non polluted area of Perur, 85 percentage of the office staffs and 84 percentage of the factory staffs had used exhaust fan at home.

AVAILABILITY OF VENTILATION

In both polluted and non polluted area such as Town hall, Gandhipuram, Ukkadam and Perur, all the 100 per cent of the respondents had responded for good ventilation in their homes.

NUMBER OF MOTOR VEHICLES TRAVELLED IN THE ROAD PER DAY

In the polluted area of Town hall, the respondents responded for higher number of commercial vehicles travelled in the road per day compared to the other areas. In Gandhipuram, the respondents responded for higher number of non commercial vehicles travelled in the road per day compared to the other areas. In non polluted area of Perur, the respondents responded for very less number of vehicles travelled in the road compared to polluted areas.

POPULATION IN POLLUTED AND NON POLLUTED AREAS

In polluted area of Town hall, Gandhipuram and Ukkadam, the size of population was two lakhs responded by the respondents. In the non polluted area of Perur, the size of the population was around 10,000 responded by the respondents.

NUMBER OF INDUSTRIES

In the polluted area of Town hall, the number of industries was around 10 responded by the respondents. In Gandhipuram, it was around 25 industries and in Ukkadam it was around 2 responded by the respondents. In non polluted area of Perur, there were only 2 industries responded by the respondents.

10. DETERMINANTS OF AIR POLLUTION IN THE STUDY AREA – LOGISTIC REGRESSION ANALYSIS

The logistic coefficients were greater than one for the variables such as population, number of industries, number of motor vehicles in the road per day, income of household, hours of cooking per day, energy consumption expenditure, using of air conditioner and exhaust fan at home. The above variables contributed significantly to air pollution. The increase in population, number of industries, number of motor vehicles in the road per day, income of household, hours of cooking per day, energy consumption expenditure and using of air conditioner at home would increase the probability of area becoming air polluted. The area, with higher population, higher number of industries, higher number of motor vehicles travelled in the road per day, higher family income, higher cooking hours per day, higher energy consumption and higher usage of air conditioner was the probable air polluted area. The use of exhaust fan would reduce the probability of area to be polluted as the logistic regression co efficient was negative.

11. PERCEPTION OF RESPONDENTS ABOUT THE CONSEQUENCE OF AIR POLLUTION ON HEALTH IN THE STUDY AREA

PERCEPTION OF RESPONDENTS FOR HEADACHE AS THE CONSEQUENCE OF AIR POLLUTION

In total, 62.17 percentage of the respondents had perceived for headache as the consequence of air pollution, in polluted area. In non polluted area, 85 percentage had perceived for the headache as the consequence of air pollution.

PERCEPTION OF RESPONDENTS FOR EYE/NOSE/THROAT IRRITATION AS THE CONSEQUENCE OF AIR POLLUTION

In total, higher percentage of the respondents had perceived for the above health problem in polluted area than the respondents in non polluted area.

PERCEPTION OF RESPONDENTS FOR RUNNING NOSE AS THE CONSEQUENCE OF AIR POLLUTION

In total, 60.2 percentage of the respondents in non polluted area and 35.8 percentage of the respondents in polluted area had perceived for running nose as the consequence of air pollution.

PERCEPTION OF RESPONDENTS FOR FLU FEVER AS THE CONSEQUENCE OF AIR POLLUTION

In total, the highest percentage of the respondents in non polluted area had perceived for flu fever as the consequence of air pollution compared to polluted area.

PERCEPTION OF RESPONDENTS FOR SKIN INFECTION/RASH AS THE CONSEQUENCE OF AIR POLLUTION

In total, higher percentage of the respondents in non polluted area had perceived for skin infection compared to polluted area.

PERCEPTION OF RESPONDENTS FOR ASTHUMA ATTACKS AS THE CONSEQUENCE OF AIR POLLUTION

In total, higher percentage of the respondents in polluted area had perceived for asthma compared to non polluted area.

PERCEPTION OF RESPONDENTS FOR SHORTNESS OF BREATH AS THE CONSEQUENCE OF AIR POLLUTION

In total, higher percentage of the respondents in polluted area had perceived for shortness of breath as the consequence of air pollution compared to non polluted area.

PERCEPTION OF RESPONDENTS FOR DRY SCRATCHY THROAT AS THE CONSEQUENCE OF AIR POLLUTION

In total higher percentage of the responses were found for dry scratchy throat as the consequence of air pollution in polluted area than in non polluted area.

PERCEPTION OF RESPONDENTS FOR CHEST PAIN AS THE CONSEQUENCE OF AIR POLLUTION

In total, higher percentage of the respondents in polluted area had perceived for chest pain as the consequence of air pollution than in non polluted area.

PERCEPTION OF RESPONDENTS FOR COUGH WITH PHLEGM AS THE CONSEQUENCE OF AIR POLLUTION

In total, higher percentage of respondents in non polluted area had perceived for cough with phlegm as the consequence of air pollution compared to polluted area.

PERCEPTION OF RESPONDENTS FOR DRY COUGH AS THE CONSEQUENCE OF AIR POLLUTION

In total, higher percentage of the respondents in polluted area had perceived for dry cough as the consequence of air pollution than in non polluted area.

PERCEPTION OF RESPONDENTS FOR BRONCHITIS AS THE CONSEQUENCE OF AIR POLLUTION

In total, 24.17 percentage of the respondents had perceived for bronchitis as the consequence of air pollution in polluted area. In non polluted area, only 1.35 percentage of the respondents had perceived for the same type of disease.

PERCEPTION OF RESPONDENTS FOR DROWSINESS AS THE CONSEQUENCE OF AIR POLLUTION

In total, 21.67 percent of the respondents in polluted area and 10.2 percentage of the respondents in non polluted area had perceived for drowsiness as the consequence of air pollution.

PERCEPTION OF RESPONDENTS FOR PNEUMONIA AS THE CONSEQUENCE OF AIR POLLUTION

In total, 20.5 percentage of the respondents in polluted area and 1.5 percentage of the respondents in non polluted area had perceived for pneumonia as the consequence of air pollution.

PERCEPTION OF RESPONDENTS FOR HEART DISEASES AS THE CONSEQUENCE OF AIR POLLUTION

In total, higher percentage of the respondents in polluted area had perceived for heart diseases compared to non polluted area.

PERCEPTION OF RESPONDENTS FOR CANCER AS THE CONSEQUENCE OF AIR POLLUTION

In total, higher percentage of the respondents in polluted area had perceived for cancer as the consequence of air pollution than in non polluted area.

12. FAMILY MEMBERS SUFFERED FROM DISEASES

Higher percentage of the respondents families in polluted area had suffered from diseases than in non polluted area.

13. HEALTH PROBLEM EXPENIENCED BY THE RESPONDENTS IN THE STUDY AREA

RESPONSES OF THE RESPONDENTS PERTAINING TO OCCURRENCE OF FEVER

When both office and factory staffs were analysed together, higher percentage of the respondents in non polluted area had responded for fever compared to polluted area.

THE RESPONSES OF THE RESPONDENTS PERTAINING TO THE OCCURRENCE OF ASTHMA

In total, 62 percentage of the respondents in polluted area and only 54.5 percentage of the respondents in non polluted area had stated for the occurrence of Asthma.

THE RESPONSES OF THE RESPONDENTS PERTAINING TO THE OCCURRENCE OF HEADACHE

When both office and factory staff responses were analysed together, 62.17 percentage of the respondents in polluted area and 85 percentage of the respondents in non polluted area had headache.

THE RESPONSES OF THE RESPONDENTS PERTAINING TO THE OCCURRENCE OF COLD

In total, 40.33 percentage of the respondents in polluted area and 53 percentage of the respondents in non polluted area had cold.

14. CONSEQUENCES OF AIR POLLUTION OTHER THAN DISEASES

NUMBER OF DAYS SUFFERED FROM HEALTH PROBLEM

In polluted area of Town hall, on an average, the respondents had suffered from health problem for 3.5 days per month. In Gandhipuram, the respondents had suffered for 10.3 days per month. In Ukkadam, they had suffered on an average 3.5 days per month. In non polluted area of Perur, the respondents had suffered from health problem for 2 days per month.

HOSPITAL VISITS

In polluted area of Town hall, Gandhipuram and Ukkadam, the respondents had visited the hospitals two times per month. But in non polluted area of Perur, they had visited the hospitals one time per month.

VISITING DOCTOR

In polluted area of Town hall, Gandhipuram, and Ukkadam, on an average, the family members of the respondents had visited the doctor two times per month for consulting their health problem. In non polluted area of Perur, the family members of the respondents had visited doctors one time per month to consult their health problem.

MEDICAL EXPENSES

In polluted area of Town hall, the office staffs had incurred an average amount of Rs.100 per month and factory staffs Rs.153.85 per month. In Gandhipuram, the office staffs had incurred Rs.212.50 per month and the factory staffs Rs.208.33 per month. In Ukkadam, office and factory staffs had incurred Rs.90 per month. In non polluted area of Perur, office and factory staffs had incurred Rs.90 per month as the medical expenses.

NUMBER OF WORKING DAYS LOST FOR OFFICE

In polluted area of Town hall, on an average, the office staffs had taken leave for two days per month. The same for factory staffs was one day per month. In Gandhipuram, office staffs put leave for 1.25 days per month due to illness. The same was one day per month for factory staffs. In Ukkadam, both office and factory staffs did not put leave due

to illness. In non polluted area, both office and factory staffs had taken leave of less than one day per month.

LEAVE FOR HOUSEHOLD WORK

In polluted area of Town hall, Gandhipuram and Ukkadam, the mean days absent per month for household work was one day. In non polluted area of Perur, they did not absent for household work. All the respondents were able to perform their household work without absent, in non polluted area.

LOSS OF INCOME DUE TO ILLNESS

In polluted area of Town hall, the loss of income was Rs. 2000 per month for office staffs and Rs.4300 per month for factory staffs. In Gandhipuram, the loss of income was Rs. 2500 per month for office staffs and Rs.3000 per month for factory staffs. In Ukkadam, the average loss of income was Rs. 1000 per month for office and factory staffs. In non polluted area of Perur, the average amount of income loss was Rs. 1000 per month for office and factory staffs. It showed that higher amount of income loss was found in polluted area than in non polluted area due to health issues.

NUMBER OF DEATHS IN THE FAMILY

In total, higher number of deaths were occurred in polluted area than in non polluted area.

AGE AT THE TIME OF DEATH

The average age of death in the office staffs family in Town hall was 59 years. In Town hall, in the families of factory staffs, the average age of death was 70.57 years. In polluted area of Gandhipuram, the average age of death in the families of office staffs was 68.14 years. The same was 64.67 years in the families of factory staffs in Gandhipuram. In Ukkadam, there were no deaths in the respondents families in the year 2015-2016. In the non polluted area of Perur also, no death was observed in the respondents family.

15. ASSOCIATION BETWEEN THE AIR POLLUTION AND PERCEPTION OF HEALTH PROBLEM

In the chi square analysis, the variables such as eye/nose/throat irritation, asthma attacks, shortness of breath and dry scratchy throat were statistically significant. The hypothesis of no association between air pollution and the above diseases was rejected. It implied that the respondents in polluted area perceived eye/ nose/throat irritation, asthma

attacks, shortness of breath and dry scratchy throat as the consequences of air pollution. It indicated that the air pollution had caused significantly the above diseases.

16. ASSOCIATION BETWEEN THE AIR POLLUTION AND HEALTH INDICATORS IN THE STUDY AREA – CHI SQUARE TEST

The results showed that the estimated chi square value was statistically significant for the variables such as days of sick, age of death, number of deaths in the family, asthma and respiratory diseases. The null hypothesis of no association between the above stated variables and air pollution was rejected. Hence the alternate hypothesis of association between air pollution and days of sick, age of death, number of deaths in the family, asthma and respiratory diseases was accepted. It revealed that there was strong association between air pollution and days of sick, age at death, number of deaths in the family, asthma and respiratory diseases.

CONCLUSION

To conclude, the level of sulfur dioxide and nitrogen oxide were within the prescribed limit in the commercial zone of Coimbatore city. But the suspended particulate matter had exceeded the prescribed limit in the commercial zone. In the commercial parts of Town hall, Ukkadam and Gandhipuram, the suspended particulate matter air pollution was higher than the other commercial parts. The increase in population, number of industries, number of motor vehicles in the road per day, income of household, hours of cooking per day, energy consumption expenditure and using of air conditioner at home would increase the probability of area becoming air polluted. The persons living in the air polluted area were highly affected by asthma/ reciprotary diseases. In the study period, higher number of deaths were observed in the polluted area than in non polluted area. In the non polluted area, no deaths were occurred in the respondents family in the study period. The average age of death in the polluted area was above 55 years. The number of days sick, age at death, number of deaths in the family, asthma and respiratory diseases were strongly associated with air pollution.

SUGGESTION

- In commercial and industrial zones, the pollution control plant must be established by the government to control the air pollution.
- Setting up of CNG/LPG in the vehicles could reduce air pollution considerably.
- The use of Compressed Natural Gas (CNG) as fuel for processing and production in industries would reduce the air pollution.
- Replacing of DG sets with gas generators in industries would reduce the air pollution.
- Providing of Liquid Petrol Gas (LPG) and Compressed Natural Gas (CNG) to the industries at a subsidised rate could reduce the air pollution.
- Strict policy measures must be implemented to check the emission from industries and vehicles.
- Better traffic management and widening of roads could help to minimise natural dust and congestion.
- Appropriate method is needed for measuring the economic loss due to air pollution. The legal framework must be constructed to compensate the economic loss by the polluters.
- The air quality must be properly monitored and its health impact must be assessed regularly. Appropriate policy measures must be evolved to control adverse health effects.

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ANNEXURE – I

AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER EDUCATION FOR WOMEN

INTERVIEW SCHEDULE

DETERMINANTS OF AIR POLLUTION AND ITS IMPACT ON HEALTH IN COIMBATORE CITY

SECTION-A

General features of the selected location:

1. Name of the area:
2. Name of the town:
3. Name of the corporation / municipality:
4. Total number of households:
5. Total number of population:

   Male: Female:
6. Total number of educational institutions:

   Primary: Secondary: Higher secondary: College: Others, if any specify:
7. Medical services:
   a) Number of doctors:
   b) Number of hospitals:

   Government Hospital: Private Hospital:
   c) Number of nursing home:
   d) Number of pathology and diagnostic Centre:
   e) Number of medical shops:

8. Total number of industries:

   Large ☐ Medium ☐ Small ☐

9. Mode of transport plying in the area:

   Bus / Car / Auto rickshaw / Motor Bike / Heavy Vehicles

SECTION - B

Household:

I. Socio-Economic Characteristics:

1. a) Name of the respondent:

   b) Address:

   c) Telephone no:

2. For how long you are staying in this house?

3. Occupation of the head of the household and respondent:

   1. Government/Private employee
      a. Office b. Factory
   2. Self-employed:
      a. Office b. Factory.
   3. Unemployed:
   4. Others (Please mention):

4. Total family members: Male: Female:

5. Age of the respondent: Male: Female:

6. a) Income of the household: (monthly):

   b) Income of the respondent: (monthly):

7. Total expenditure of the household: (monthly):

8. Pattern of the house:
   a) Kacha b) Pacca

II. CAUSES OF AIR POLLUTION

1. Existence of separate kitchen Yes/No.
2. Energy consumption expenditure for cooking (Per month Rs.).
3. Number of times cooking per day.
4. Number hours of cooking per day.
5. Monthly electricity consumption expenditure. (Rs.).

6. Using of air conditioner at home Yes/No
7. Using of heater Yes/No
8. Using exhaust fan. Yes/No
9. Availability of ventilation Yes/No
10. Number of motor vehicles travelled in the road per day.
11. Population in your area.
12. Number of industries in your area.

III. General Health Question:

i) Are you aware that air pollution causes illness? Yes/ No

ii) Kindly mark the diseases you attribute to air pollution in the list of diseases given below: (Yes/No).

a) Headache
b) Eye /nose/throat irritation
c) Running nose/Cold
d) Flu / Fever
e) Skin infection/Rash
f) Asthma attacks
g) Shortness of breadth
h) Respiration allergy to dust and pollen
i) Dry scratchy throat
j) Chest pain
k) Cough with phlegm
l) Dry cough
m) Bronchitis
n) Drowsiness
o) Pneumonia
p) Heart Disease
q) Cancer

IV. Health History of the Household:

(a) Have you or any one of your family members suffered from some of these diseases during the year?

Yes/No

(b) If yes mention the name of the diseases:

1.
2.
3.
4.

V. Consequences of air pollution other than diseases

a) Number of days suffering

b) Hospital visits

c) Visiting doctors

i) Number of times

ii) Number of days in hospital

iii) Emergency room visit

VI. Total medical expenses:

i) Expenses on doctor

ii) Expenses on medicine

iii) Expenses on pathological test

VII. Number of working days lost and income lost:

i) Education

ii) Office

iii) Household work

iv) Loss of income due to absence from work owing to disease

VIII. Special information:

i) Number of deaths in the family, if any (last 1 year)

ii) Causes of death

iii) Age at death