Introduction

The degree of urbanization is strongly influenced by the magnitude of economic activity, while the level of motorization is linked to economic activity and urbanization. The high rise buildings, the shopping malls, the fly-over are a sharp contrast to much of the Indian countryside. The rapid urbanization in India has also resulted in a tremendous increase in the number of motor vehicles. Automotive industry has universally emerged as an important driver of the economy. Automobile dependency has many impacts on the society and the economy. It increases mobility and convenience to motorists and also generates revenue to the Government. As the number of vehicles continues to grow and the consequent congestion also aggravates, vehicles are now becoming the main source of air pollution in urban India. However, this quick growth has also brought with it the unavoidable problems of urbanization – and as people go about their lives at high speeds, air quality in general and emissions from vehicles in particular has become an issue of primary concern.

AIR POLLUTION

Air pollution is one of the serious environmental concerns of the Asian urban cities including India, where majority of the population is exposed to poor air quality. The health related problems such as respiratory diseases, asthma,
cough and cold, risk of developing cancers and other serious ailments etc. due to poor air quality are known and well documented (Seaton and Nee, 1995). Besides the health effects, air pollution also contributes to tremendous economic losses, especially in terms of financial resources that are required for giving medical assistance to the affected people. The poor are often the most affected segment of the population as they do not have adequate measures to protect themselves from air pollution. Since poor ambient air quality is largely an urban problem, this will directly affect millions of the dwellers in the cities.

Mobile sources, particularly motor vehicles, are a major cause of air pollution. While motor vehicles have increased mobility and flexibility for millions of people, created jobs, and enhanced many aspects of the quality of life, the benefits have been offset by air pollution generated by the motor vehicles. Motor vehicles emit carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and other toxic substances such as fine particles and lead. Each of these pollutants has adverse effects on human health and welfare (Faiz et al, 1990).

**URBANIZATION, ECONOMIC ACTIVITY AND MOTORIZATION**

Air pollution is generated primarily in large metropolitan areas in both developed and developing regions. The rapid growth of urban agglomerations may have an indirect link to increased pollutant emissions. Moreover, increases in population concentration in urban areas make more people exposed to the adverse effects of air pollution. Urban population growth in
developing countries, as a result of both natural increases and migration from rural areas and small towns, has greatly expanded urban boundaries and resulted in increased travel and demand for urban transport services. The increase in vehicle kilometers of travel in many developing countries has averaged between 5-30 per cent per annum since the mid-1980s (Owen, 1999).³

Many developing countries, particularly in Asia, will continue to experience higher rates of economic growth (Gross National Product - GNP - per capita) than industrialized countries. Given the strong correlation between GNP per capita and the level of motorization, the growth in motorization in many developing countries is expected to be considerably higher than the annual growth rate of 2-3 per cent estimated for the global vehicle fleet. This would significantly increase the contribution of developing countries to transport-related air pollution. Air pollution problems therefore, are likely to worsen in many urban areas of developing countries because of rapid urbanization, the rising rate of motorization, increasing trip rates, and use of old and not so well maintained vehicles. Traffic growth has outpaced the increase in road space in the larger metropolitan areas in developing countries. The stop-and-go pattern of traffic flow resulting from traffic congestion increases fuel consumption and adds to the air pollution problem (Rhodhe and Herrera, 1990).⁴
NATURE OF MOTOR VEHICLES AND AIR POLLUTION

Motor vehicles in many developing countries are not as fuel efficient as in industrialized countries. Many of the vehicles are old and poorly maintained because of lack of spare parts and other resources. For example, in India a major portion of the vehicles fleet is older than ten years (Pendakur, 1988). This is true not only for trucks, buses and automobiles, but also for motorcycles and auto-rickshaws. The use of auto-rickshaws is extensive in the Indian subcontinent and their contribution to air pollution is not insignificant. Two-stroke engine motorcycles are also a major source of air contaminants. An investigation carried out in Taiwan found that the ratio of lubricating oil additive in gasoline was an important factor influencing the opacity of particulates emitted by two-stroke motorcycle engines. Since 1984, a major effort has been made to reduce the lubricating oil content in unleaded gasoline for 2-stroke motorcycles to less than 2 per cent (Sharma et al, 2012).

Moreover, the gasoline used in most developing countries still has a high percentage of lead. In India, the lead content in gasoline is considerably higher than the permissible limits in industrialized countries. In Taiwan, the lead content in regular gasoline was reduced from 0.8 gm/litre in 1981 to 0.12 gm/litre in 1988; at the same time, unleaded gasoline was introduced. Diesel fuel supplied for buses and trucks in many developing countries has very high sulfur content and is often contaminated and sometimes deliberately blended with heavier oil fractions (Garg, 2001).
Two-wheelers and cars are said to be the principal contributors to vehicular pollution, accounting for nearly 90 per cent of total emission loads. Air quality in urban areas in particular has reached a new low due to the proliferation of vehicles. In urban areas, the effect of automotive pollutants on ambient air quality tends to be more pronounced than their emission shares on a regional or global basis. As motor vehicles emit contaminants in close proximity to the breathing zone of people, they not only pose a greater health risk, but are also a source of public annoyance. Environmentalists commonly agree that in spite of so many rules framed by the Government of India as well as the State Government to control emissions, the current level of automobile pollution in the mega cities of India is beyond tolerable limits. The daily emissions of automobile pollutant like Suspended Particulate Matter (SPM), Sulphur Dioxide (SO₂), Oxides of Nitrogen, Hydro Carbon and Carbon Monoxide in the major cities are extremely high. The situation is particularly alarming in the capital city, New Delhi with a staggering 1046.30 tons of daily pollution load, making it one of the most polluted cities in the world. These figures confirm the extent of toxicity prevailing in the atmosphere of these cities (Williams et al, 1989).⁸

**CURRENT STATUS OF INDIAN AUTOMOBILE INDUSTRY**

Transport sector in India is a very extensive system comprising different modes of transport like roads, railways, aviation, inland waterways and shipping, which facilitates easy and efficient conveyance of goods and people
across the country. Road Transport is the primary mode of transport which plays an important role in conveyance of goods and passengers and linking the centres of production, consumption and distribution. It is also a key factor for promoting socio-economic development in terms of social, regional and national integration.

According to the Ministry of Road Transport and Highways, the share of transport sector in Gross Domestic Product (GDP) of India has increased from 6.0 per cent in 2001-02 to 7.2 per cent in 2011-12. In particular, the contribution of road transport sector in GDP has increased from 3.9 per cent in 2001-02 to 5.1 per cent in 2011-12. India has experienced a tremendous increase in the total number of registered motor vehicles. The total number of registered motor vehicles increased from about 0.3 million in 1951 to about 159 million in 2012. The total registered vehicles in the country grew at a Compound Annual Growth Rate (CAGR) of 12.2 per cent between 2001 and 2012.

The share of two wheelers was about 72.4 per cent of the total registered motor vehicles in India in 2012, having increased from 8.8 per cent in 1951. Concomitantly, the share of number of registered cars, jeeps and taxis in the total number of registered vehicles stood at 13.5 per cent in 2012, marking a steep decline from 52 per cent in 1951. The share of buses, including omni buses, in total registered vehicles declined from 11.1 per cent in 1951 to 1 per cent in 2012. The number of registered goods vehicles, which
had accounted for 26.8 per cent in 1951 constituted 4.8 per cent of the total vehicles in the country in 2012. In terms of share in total, ‘other vehicles’, which include tractors, trailers, three wheelers (passenger)/Light Motor Vehicles (LMVs) and other miscellaneous vehicles, increased sharply from 1.3 per cent in 1951 to 8.3 per cent in 2012. During 2001-2012, the growth rate of registered motor vehicles was almost three times the growth rate of the road network. Amongst the various categories of vehicles, the highest CAGR during 2001-2012 was recorded by cars, jeeps and taxis (10.5 per cent), followed by two-wheelers (10.2 per cent).

The number of all registered vehicles in India has gone up from 3.06 lakhs in 1951 to 15.95 crores in 2012; two wheelers have increased from 27 thousand to 11.54 crores; cars, jeeps and taxis have moved up from 159 thousand to 2.16 crores and the number of busses has gone up from 34 thousand to 16.8 lakhs, while the number of goods vehicles has moved up from 82 thousand to 76.6 lakhs in the same period (Ministry of Road Transport and Highways, 2013). 

**State-wise Distribution of Vehicle Population**

With a registered motor vehicle population of 174 lakh, the State of Maharashtra accounted for the largest share (12.3 per cent) of the total registered motor vehicles in the country. Tamil Nadu recorded the second highest share (11.0 per cent) of registered motor vehicles, followed by Uttar Pradesh (9.4 per cent), Gujarat (9.2 per cent) and Andhra Pradesh (7.2 per
cent). These five States together accounted for about 49 per cent of the total vehicles registered upto 2012. The lowest number of motor vehicles (0.09 lakh) was registered in the UT of Lakshadweep (0.01 per cent). Among the States, Sikkim reported the lowest number of the total registered vehicles of 0.39 lakh (0.03 per cent).

Growth in terms of CAGR of registered vehicles amongst the States/UTs shows wide variations. While the highest CAGR for registered vehicles during 2001-2012 was recorded by Arunachal Pradesh (21.3 per cent), followed by Dadra & Nagar Haveli (19.4 per cent) and Tripura (14.1 per cent), the lowest CAGRs were recorded by Nagaland (5.5 per cent), Punjab (6.1 per cent) and West Bengal (6.8 per cent). As many as 26 States/UTs had CAGRs equal to or more than the all India growth rate of 9.9 per cent during 2001-2012.\textsuperscript{10}

In Tamil Nadu, the CAGR of total registered motor vehicles for the period 2001-2013 stood at 11.7 per cent as against the national average of 9.9 per cent, which was the highest among the major states of the country. Segment-wise, the number of transport vehicles has gone up from 2.39 lakhs in 1992-93 to 10.53 lakhs in 2012-13, the number of non-transport vehicles has moved up from 16.82 lakhs to 163.17 lakhs and thus, the total number of all vehicles has gone up from 19.21 lakhs to 173.70 lakhs in the same period. This signifies an average annual growth rate of 16.2 per cent in the case of transport vehicles, 41.4 per cent in the case of non-transport vehicles and thus, 38.3 per cent in the case of all vehicles for the period 1992-93 to 2012-13.
In Kanchipuram district, the number of commercial vehicles stood at 33358 as on April 30, 2013, the number of non-commercial vehicles stood at 3.65 lakhs and thus, the total number of vehicles in this district stood at 3.98 lakhs. In Kanchipuram town, the number of commercial vehicles was 10139, number of non-commercial vehicles was 1.88 lakhs and hence, the total number of vehicles as on April 30, 2013 stood at 1.98 lakhs. This formed more than 50 per cent of the vehicles in the Kanchipuram district. In the case of Maduranthakam transport range, the number of commercial vehicles as on April 30, 2013 stood at 6020, that of non-commercial vehicles stood at 30009 and thus, the total number of vehicles stood at 36029, which thus formed 9 per cent of the total vehicles in the district (Government of Tamil Nadu, 2013).

HEALTH IMPACT OF AIR POLLUTION IN INDIA

The drastic increase in the number of vehicles has resulted in a significant increase in the emission load of various pollutants. In India, millions of people breathe air with high concentrations of dreaded pollutants. The air is highly polluted in terms of suspended particulate matter in most cities. This has led to a greater incidence of associated health effects on the population manifested in the form of sub-clinical effects, impaired pulmonary functions, and use of medication, reduced physical performance, frequent medical consultations and hospital admissions with complicated morbidity and even death in the exposed population. According to a World Bank study, respiratory infections contribute to 10.9 per cent of the total burden of diseases, which may
be both due to the presence of communicable diseases as well as high air pollution levels, while cerebra vascular disease (2.1 per cent), ischemic heart disease (2.8 per cent) and pulmonary obstructions (0.6 per cent) are much lower. The prevalence of cancer is about 4.1 per cent amongst all the diseases indicating that the effects of air pollution are visualised on the urban population (Cropper, 1993).  

A World Health Organisation/United nations Environmental Programme (WHO/UNEP) study compared standardised prevalence of respiratory diseases in different areas of Mumbai, classified according to ambient average concentrations of sulphur dioxide. The study reveals a relatively higher prevalence of most respiratory diseases in polluted urban areas than in the rural control area (World Health Organisation/United Nations Environment Programme, 1992). In India, in a study of 2031 children and adults in five mega cities, of the 1852 children tested, 51.4 per cent had blood lead levels above the normal level. The percentage of children having higher blood lead levels ranged from 39.9 per cent in Bangalore to 61.8 per cent in Mumbai. Among the adults, 40.2 per cent had blood lead levels of above normal level (Central Pollution Control Board, 2000).

It is also estimated the total magnitude of economic costs associated with environmental degradation in India. Using the 1991-92 air pollution data for particulates, SO₂, NOₓ, and lead from 36 cities, health impacts were estimated in terms of reductions in morbidity and mortality if pollutant levels in
these cities were reduced to the normal level. The total health costs due to air pollution were estimated to be $517-2102 million. Also, the physical impacts were in terms of 40000 premature deaths avoided. It is also estimated the incidence of mortality and morbidity in different groups in India due to exposure to PM$_{10}$ and translated these impacts into economic values. The results indicated 2.5 million premature deaths and total morbidity and mortality costs of Rs. 885 billion to Rs. 4250 billion annually (Pope et al, 1995).$^{15}$

Epidemiological studies have established a close relationship between exposure to ambient air pollution and morbidity and mortality from cardio-pulmonary diseases (Schwela, 2000).$^{16}$ Air pollution is a complex mixture of various gases, particulates, hydrocarbons, and transition metals. Of all these pollutants, the association between air pollution and adverse health conditions was the strongest and most consistent for respirable suspended particulate matters (RSPM) with an aerodynamic diameter of less than 10 micrometer (PM$_{10}$). Health risk from particulate pollution is especially high for some susceptible groups such as the children and the elderly persons, and those with diseases of the heart and lungs (Ulrich et al, 2002).$^{17}$

**Health Impact on Children**

Children are more susceptible to environmental pollutants than the adults. The special vulnerability of children to air pollution exposure is related to several differences between children and the adults (Gilliland et al, 1999).$^{18}$
1. Children generally spend more time and are also more active outdoors than the adults. They are active outdoors during midday when air pollution levels tend to be higher. They have significantly higher oxygen demands so their respiration rates are higher and they inhale more air per unit of body weight than adults.

2. Because of their smaller stature their breathing zone is lower, so they inhale air loaded with more particles.

3. Diameters of their airways are smaller and therefore more likely to be affected by inflammation produced by air pollution.

4. Their lungs are still developing and hence are more vulnerable to airborne insults. The efficiency of detoxification system of the body develops in time-dependent pattern. This in part accounts for increased susceptibility of children at critical points of time, and finally

5. Their immune defence is immature and hence less active against inhaled pathogens. In essence, children represent the largest subgroup of the population susceptible to the adverse health effects of air pollution (Dockery et al., 2005). Damage to the respiratory system in children can be devastating and permanent and the adverse effects of air pollution may be obvious in adult life owing to the long latent periods for several chronic diseases.

**AIR POLLUTION IN TAMIL NADU**

Urban development is a concomitant of industrialisation. The process of urbanisation has been accelerating in Tamil Nadu mainly due to the fact that
negative rural to urban migration is created by dearth of employment avenues in rural areas. In Tamil Nadu, the urban population has increased from 0.6 crores to 3.5 crores in forty years between 1961 and 2011. This rapid increase in urban population has resulted in unplanned urban development, increase in consumption patterns and higher demands for transport, energy and other infrastructure, thereby leading to pollution problems in many places of the State.

In Tamil Nadu, air pollution is widespread in urban areas where vehicles are the major contributors and in a few other areas with a high concentration of industries and thermal power plants. Vehicular emissions are of particular concern since these are ground level sources and thus have the maximum impact on the general population. Vehicle population in the State has been increasing over the years mainly on account of growing urbanisation, rising real per capita income and increasing share of personalized mode of transport. Roughly 400 tonnes of smoke units are being discharged into the atmosphere every day by the vehicles in Chennai. Adulterated fuel adds another dimension to the problem of pollution (Government of Tamil Nadu, 2008).  

Apart from the concentration of vehicles in urban areas, other reasons for increasing vehicular pollution are the types of engines used, age of vehicles, congested traffic, poor road conditions, and outdated automotive technologies and traffic management systems. Vehicles are a major source of pollutants in major cities. The quantum of vehicular pollutants emitted is
highest in Chennai followed by Coimbatore, Salem, Madurai, Trichy and Tirunelveli. Carbon monoxide and hydrocarbons account for 64 per cent and 23 per cent, respectively, of the total emission load due to vehicles (Rao and Rao, 2000). 20

AIR QUALITY MONITORING IN INDIA

Government of India enacted the Air (Prevention and Control of Pollution) Act, 1981 to control the deterioration in the air quality. The act prescribes various functions for the Central Pollution Control Board (CPCB) at the apex level and the State Pollution Control Board (SPCB) at the state level.

Under the Act, CPCB is entrusted with the function of air quality management and to undertake air pollution control programme at the national level. Regular monitoring of air quality for assessment of human exposure and damage to the property is the fundamental requirement for such an air pollution control programme. The monitoring is being carried out by CPCB in association with SPCBs, Pollution Control Committees (PCCs) and National Environmental Engineering Research Institutes (NEERI), Nagpur. The CPCB coordinates and supervises the uniformity and consistency of air quality data also and provides technical and financial support.

In order to carry out the above programme, the National Air Monitoring Programme (NAMP) has the following objectives:

- To determine the present air quality status and trends;
- To indicate possible health hazard and damage to the property;
To provide background air quality data as needed for industrial sites and Town planning; and

To control and regulate pollution from industries and other sources to meet the air quality standards (Central Pollution Control Board, 2004).

In Tamil Nadu, the Tamil Nadu Pollution Control Board is monitoring the ambient air quality in Chennai (3 stations), Coimbatore (3 stations), Tuticorin (3 stations), Madurai (3 stations) and Salem (1 station) under the National Ambient Air Quality Monitoring Programme. Under the State Ambient Air Quality Monitoring Programme, the Board has established five monitoring stations in Chennai city and Tiruchirappalli. The programmes monitor the air quality in residential, commercial and sensitive zones of the cities. The results of the programme are published every week in leading newspapers. Towards preparation of the environmental management plan for Chennai city, ambient air quality surveys have been conducted at forty one stations in Chennai to identify the most sensitive locations with respect to air pollution. The major industrial complexes, especially the clusters of chemical industries are being monitored continuously.

With this in view, the Board has established six continuous ambient air quality monitoring systems at Cuddalore, Tuticorin, Ranipet, Manali-Thiruvallur, Royapuram-Chennai, Kathivakkam-Thiruvallur at a cost of around Rs.40 lakhs each to assess the level of pollutants such as SPM, SO\textsubscript{2}, oxides of nitrogen,
CO, ammonia, chlorine, flourine, etc. in the ambient air and the adequacy of air pollution control measures provided by the industries. The Board instructs the concerned industrial units to improve the air pollution control measures, whenever the levels exceed the standards prescribed. During the current year, towards strengthening of air quality monitoring, the activities of establishing one automatic continuous ambient air quality monitoring centre at Koyambedu in Chennai city, setting up of new manually operated high volume samplers in Madurai, Salem, Coimbatore, Trichy and Tirunelveli at a total cost of Rs. 72 lakhs and providing flue gas analysers to Board’s laboratories at a cost of Rs. 39 lakhs are under process (Jayanthi and Krishnamoorthy, 2006).  

**STATEMENT OF THE PROBLEM**

Most of the environmental problems that occur arise due to unplanned developmental programmes. In the trade-off between development and environment, the former wins over the latter and that is particularly true in a developing country. This is exacerbated by the neo-liberal economic policies pursued in the name of faster economic growth in India, which has resulted in a uni-dimensional and urban-centric economic growth. Lack of development efforts in the agricultural sector, agro processing industries and the small and medium enterprises in the rural areas has led to rural-urban migration. Rapid urbanisation, faster rise in private transportation and expanding public transportation are the inevitable outcomes of the new economic policies. On the other hand, the Government is unable to improve the supply and stock of
infrastructural facilities like road, bridges, flyovers, electricity and others. Thus, lack of urban planning is the cause of unequal concentration of commercial and industrial activities, increasing traffic volume, traffic congestion and thus the problem of deteriorating air quality in the urban centres of the country.

The ever worsening air quality is the invisible outcome of the development policies pursued by the Government. The economic policies, development programmes and urbanisation are all welcome as long as they do not result in irreversible negative environmental externalities. Declining air quality is one such negative externality which cannot be reversed and its impact felt in the form of increasing respiratory problems and other health impact in the urban areas. This calls for an in-depth analysis on the level of air pollution and its health impact in an urban area, with the help of primary data, especially since no such attempt has been made so far, which is undertaken in this study.

SIGNIFICANCE OF THE STUDY

The New Economic Policy introduced in 1991 has unleashed a spectacular rise in the income levels of a selected segment of the population in India, especially in the urban areas, which has directly contributed to the unimpeded growth of vehicle population. The Government has taken some measures to control vehicular emissions, like the compulsory use of unleaded petrol for vehicles, application of higher emission norms like Euro III and Euro IV (in the metropolitan areas) for the passenger vehicles. However, it is not
clear, as to how far these measures would have reduced the level of emission and thus air pollution, since the simultaneous rise in the vehicle population would have nullified any such drop in the emission level. Moreover, the Central Government has also postponed the further adherence of stricter emission norms due to the pressure and lobbying by the automobile sector in the name of investment and employment. With more and more people being pushed into the urban areas for their livelihood, the rising level of air pollution in all the urban centres of the country implies a widespread health hazard.

At the global level, the rich countries are the worst polluters, while the poor countries are forced to bear the burden in the form of increased pressure to reduce the level of emission. Similarly, in a country, the rich people pollute more, while a greater health impact is borne by the poor people in the form of higher healthcare expenditure. However, not many attempts have been made to probe the ailments which are caused by air pollution and the healthcare expenditure due to such ailments especially in Tamil Nadu. In this background, this study aims to capture the impact of air pollution on the health conditions and healthcare expenditure among the urban households by comparing the same with that of the rural households, who are taken as the control group.

**AREA OF THE STUDY**

This study is based on primary data collected from the households who reside in two different areas, viz., an urban area (Kanchipuram Town) and a rural area (Maduranthakam Taluk), both belong to Kanchipuram district. From
Kanchipuram Town, out of a total of 45 wards, four wards have been selected, viz., wards 1 to 4, which are located in the middle of the town and from Maduranthakam taluk, two villages, viz., Alapakkam and Kadambur have been identified as the sample area.

**PERIOD OF THE STUDY**

The data pertaining to the number of motor vehicles at the All-India level is gathered for the period 1951 to 2011, while that of Tamil Nadu is collected for the period 1992-93 to 2012-13. As far as the primary data is concerned, field survey has been conducted during the period April 2013 to July 2013.

**OBJECTIVES OF THE STUDY**

The present study is based on the following objectives:

1. To trace the trend in the level of air pollution at the All-India level and in Tamil Nadu;
2. To analyse the structure and growth of motor transport in India, Tamil Nadu and Kanchipuram district;
3. To examine the socio-economic characteristics of the sample respondents;
4. To compare the types of ailments among the sample households in the study area;
5. To measure the extent of healthcare expenditure among the sample households in the study area;
6. To ascertain the effectiveness of emission control programmes implemented by the Government; and
7. To suggest policy measures for better emission control in the society.

HYPOTHESES OF THE STUDY

The following are the hypotheses of the study:

1. Health impact of air pollution in terms of types of diseases does not vary significantly between the sample households who reside in Kanchipuram and in Maduranthakam;
2. There is no significant difference in the healthcare expenditure incurred by the sample households who reside in the study area;
3. There is no significant association between emission control measures of the Government and the problem of air pollution in the study area; and
4. Present emission norms are not sufficient to control air pollution in the future.

METHODOLOGY OF THE STUDY

Air pollution is caused by various factors like increasing industrial activity, volume of transport, commercial activity and also the spread of consumerism. Among these, increasing volume of transport can be considered as one of the major reasons for the worsening of air quality in the urban areas, since increase in transport volume occurs on a daily basis and it is most visible. The impact of declining air quality can be measured by examining the types of
ailments and also the extent of healthcare expenditure of the study group vis-a-vis the control group. Such an attempt has been made by the study conducted by World Health Organisation (WHO/UNEP, 1992). Thus, the basic thrust of the present study is to measure the impact of air pollution in terms of types of ailments and healthcare expenditure between the sample households those who reside in the urban area and those who reside in the rural area of Kanchipuram district. For urban area, Kanchipuram Town has been taken as the sample area, while for the rural area, Alapakkam and Kadambur villages in Maduranthakam taluk have been taken as the sample area.

The present study is based on both secondary and primary data. Secondary data pertaining to the trends in the pattern and growth of various air pollutants at the All-India level and in Tamil Nadu are published by the Pollution Control Boards at the National and the State levels. The growth in the number of registered motor vehicles at the All-India level and in Tamil Nadu is also examined on the basis of the data taken from the publication of Ministry of Road Transport and Highways, Government of India.

The primary data regarding the personal information, household particulars, education, employment, income, expenditure and asset holding particulars of the sample households, nature of ailments of the members of the households, healthcare expenditure, the cost of days lost due to their ailments and willingness to pay for a better emission control have been gathered through field survey with the help of a standard questionnaire. A pilot survey
has been carried out in order to verify the aptness of the questionnaire and necessary modifications were undertaken and then the final survey was completed. Care has been taken to include all segments of the households like, literate and illiterate, different levels of education, monthly income, age levels and different social groups to make the sample as much representative as possible. The collected information has been analysed on the basis of area of the respondents, their gender, age levels and monthly income in order to find out the differences in the same.

**SAMPLING DESIGN**

This study is based on multi-stage random sampling method. In the first stage, Kanchipuram as the sample district is purposively chosen, since it is adjacent to the State capital of Tamil Nadu with many leading industries, which thus attracts large number of vehicles. In the second stage, two areas, one urban area and a rural area viz., Kanchipuram Town - an urban area and Maduranthakam taluk - a rural area have been selected deliberately, since the vehicular population in the former is quite high than that of the latter. In the third stage, from Kanchipuram town four wards from a total of 45 wards have been identified, which are wards 1 to 4, since they are located in the middle of the Town and from Maduranthakam taluk, two villages, viz., Alapakkam and Kadambur have been identified as the sample areas. In the fourth and final stage of sampling, the sample households have been selected from the two
areas in order to trace the health impact of air pollution. The number of total households and sample households in the study area is shown in Table - 1.1.

Table - 1.1 Sampling Design

<table>
<thead>
<tr>
<th>Area</th>
<th>Sampling Area</th>
<th>Total Households</th>
<th>Sampling Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kanchipuram Town</td>
<td>Wards 1-4</td>
<td>832</td>
<td>208</td>
</tr>
<tr>
<td>Maduranthakam Taluk</td>
<td>Alapakkam</td>
<td>472</td>
<td>118</td>
</tr>
<tr>
<td></td>
<td>Kadambur</td>
<td>384</td>
<td>96</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1688</strong></td>
<td><strong>422</strong></td>
</tr>
</tbody>
</table>


Thus, 422 households from a total of 1688 households have been selected, which form 25 per cent of the total, as the sample households for this study. Thus, out of the 422 sample respondents, urban respondents form 49.3 per cent, while the rural respondents form the remaining 50.7 per cent. Though Kanchipuram district is highly urbanised (63 per cent), in the sample size, urban respondents are restricted to around fifty per cent, in order to avoid its undue impact on the result regarding the impact of air pollution on the respondents' health. Thus, sample consists of around 50 per cent each from the urban and rural areas.

TOOLS OF ANALYSIS

The secondary and the primary data have been analysed with the application of ratio analysis, diagrammatic representation, descriptive statistics, Wilcoxon Rank Test, Mann-Whitney U Test, t-test, ANOVA, Chi-square test and a Logistic regression model.
LIMITATIONS OF THE STUDY

Air pollution is the manifestation of various factors like, industrial activity, transportation, commercial activity and also the household activities. The present study, however takes into consideration particularly the air pollution which is caused by transportation and for this purpose only the residential and commercial areas have been selected as the study area. Moreover, to capture the health impact of air pollution on the sample households, information pertaining to their types of ailments and their healthcare expenditure has been gathered. It is assumed that the ailments of the sample households relating to their respiratory disorders are caused chiefly by air pollution, though other reasons too cannot be ruled out. Thus, this study assumes that the differences in the types of ailments and thus the healthcare expenditure between the urban and rural households are caused primarily due to air pollution.

PLAN OF THE STUDY

This study consists of seven chapters.

The **first chapter** presents general introduction regarding air pollution, its health impact, air pollution and health impact in India, air pollution in Tamil Nadu and the growth in the motor vehicles population in India and Tamil Nadu. It also explains the problem of the study, its significance, area, period, objectives, hypotheses, methodology of the study, sampling design and limitation of the study.
Many attempts have been made to examine the extent of air pollution, various sources of air pollution, health impact due to air pollution and other aspects in India as well as other countries. Some of the important studies are reviewed in the second chapter in order to specify the research gap.

Chapter three presents the profile of the study area, viz., Kanchipuram district. The location, area, demography, literacy level, land-use pattern, climate, structure of the workforce and others of Kanchipuram district are analysed with the help of secondary data.

The trend and growth in air pollution at the All-India level and in Tamil Nadu is examined in the fourth chapter with the help of secondary data. Moreover, the growth in transport and traffic volume in India, Tamil Nadu and also in Kanchipuram is also analysed in this chapter.

The socio-economic characteristics of the sample households are examined in chapter five. These include area-wise sex, age, educational level, type of family, type of house, employment, income and other traits of the sample households which are examined with the application of ratio analysis and diagrammatic representation.

Health impact of air pollution among the sample households in terms of their types of ailments, number of days hospitalized, number of days lost, healthcare expenditure and willingness to pay are examined in the sixth chapter. This chapter also analyses the opinions of the sample households regarding the effectiveness of emission control norms pursued by the
Government. This is done with application of ratio analysis, diagrammatic representation and descriptive statistics. Testing of hypotheses is also done in this chapter.

Chapter seven presents the summary of the study, findings, suggestions and conclusion.
REFERENCES


10. Ibid., pp. 33-36.


