Report

STUDY OF RESPIRATORY AND CARDIOVASCULAR HEALTH OF PEOPLE LIVING IN CHANDRAPUR DISTRICT

Submitted to:

STATE HEALTH SYSTEMS RESEARCH CENTRE

Submitted by:

PROGNOSIS MANAGEMENT & RESEARCH CONSULTANTS PVT.LTD.

PREFACE

Chandrapur is a district in the north-eastern part of Maharashtra, which is famous for its large forest cover and tiger reserve. The district also has large natural deposits of coal, limestone, high grade iron-ore, bauxite and chromite which have triggered the growth of industries in the district. This has been on such a large scale that, Chandrapur is the most polluted city in Maharashtra and the 4th most polluted industrial cluster in India among the 88 key industrial clusters.

According to the Central Pollution Control Board (CPCB), levels of air pollution in Chandrapur district are in the critical zone raising serious concerns of adverse effects on human health. Several questions raised by Honourable Members of the Maharashtra Legislative Assembly during the legislative assembly meetings regarding concerns of worsening health of people living in Chandrapur due to industrial air pollution. Therefore, government decided to do a cross-sectional study to assess the health effects of ambient air pollution on the local residents of Chandrapur. This study was commissioned by State Health Systems Resource Centre (SHSRC), Pune.

This report has tried to give the current health status of local adults and children regards respiratory and cardio-vascular system. It also has compared it between the industrial and non-industrial areas of Chandrapur district. Further the results are compared with results of neighbouring district (Nagpur) and India as well.

We, Prognosis Management & Research Consultants Pvt Ltd. are grateful to SHSRC for giving us the opportunity to work on this challenging subject. We thank Dr. U. H. Gawande, Executive Director SHSRC, for facilitating the implementation of this study and giving valuable inputs from time to time.

Mr. Ganesh Pathak, Senior Consultant, SHSRC was involved in coordinating the study activities. His prompt, appropriate, timely efforts and continuous support made the study completion in time. We acknowledge his contribution and are grateful to him.

Chandrapur District Health Officer, Dr. Athalye was very helpful in channelizing all the system and giving required permissions. We are thankful to him for facilitating all the processes for smooth implementation of the study.

We are privileged to have very valuable views and inputs from Shri. Nanasaheb Shayamkule, MLA from the district. We are grateful to him for sparing his valuable time.

We are thankful to the Regional officer of Pollution Control Board, Sakal Papers' representative and NGO Sarvoday Yuva Vikas representative for giving their insights to address the issue.

This study involved lab investigations, which were done at the Chandrapur District Hospital Laboratory. We are thankful to Dr. Sonawane, Civil Surgeon and Dr. Bobade for extending all the support required.

At various stages of the study, consultations with eminent experts were made. At the initial stage of planning and designing Dr. Ojha, Air Pollution Expert, gave us insights regards selecting sampling sites. Dr. A. L. Kakrani, MD Medicine, Dr. Vandana Kakrani, MD PSM (D Y Patil Medical College, Pune) gave us valuable inputs in designing the questionnaires and in analysing clinical data. Dr. Gauri Godbole, MD Pulmonary Medicine (Singhgad Medical College, Pune) was involved in training of investigators on using spirometers and then analysing spirometry results. Dr. Kadam, HOD Medicine Department B. J. Medical College and Dr. Rao, Professor PSM Department B. J. Medical College, Pune gave their valuable inputs in presenting the findings in the report. We are grateful to all of them.

We are thankful to all the field investigators, ANMS and MSWs for their sincere and quality work in collecting data from school and household levels. And last but not the least, we are grateful to all study participants without whom, this study would have not been complete.

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Table of contents

List of tables

List of Figures

List of abbreviations

ANM- Auxillary Nurse Midwife

CBC- Complete Blood Count

CEPI- Comprehensive Environmental Pollution Index

COPD- Chronic Ostructive Pulmonary Disease

CPCB- Central Pollution Control Board

CSTPS- Chandrapur Super Thermal Power Station

DM- Diabetes Mellitus

BSL- Blood Sugar Level

ECG- Electrocardiogram

EDTA- Ethylene DiamineTetraacetic Acid

FEV1- Forced Expiratory Volume in 1 second

FVC- Forced Vital Capacity

ISO- International Organization for Standardization

Km- Kilometer

LHV- Lady Health Visitor

LRTI- Lower Respiratory Tract Infections

MIDC- Maharastra Industrial Development Corporation

MoEF- Ministry of Environment and Forests

MPCB- Maharashtra Pollution Control Board

NOx- Nitrogen Oxide

PEFR- Peak Expiratory Flow Rate

PHC- Primary Health Centre

PHD- Public Health Department

RSPM- Respirable Suspended Particulate Matter

SO2- Sulpher Dioxide

SPM- Suspended Particulate Matter

WCL- Western Coalfields Limited

Executive Summary

Introduction: Chandrapur, a district in the north-eastern part of Maharashtra, has large natural deposits of coal, limestone, high grade iron-ore, bauxite and chromite. Triggered by the infrastructure developed by the Maharashtra Industrial Developmental Corporation (MIDC) in Chandrapur, there has been a tremendous growth in the number of coal, cement and steel industries. There are a total of 35 coal mines (out of which 7 are in the city), mostly open cast in the city and surrounding areas, over half a dozen coal washeries, one large paper mill, sponge iron units and several cement industries.

According to the Ministry of Environment and Forests (MoEF), Chandrapur is the most polluted city in Maharashtra and the 4th most polluted industrial cluster in India among the 88 key industrial clusters. In terms of Respirable Suspended Particulate Matter (RSPM) pollution, Chandrapur is the most polluted city in India. The Comprehensive Environmental Pollution Index (CEPI) score for Chandrapur's air quality was reported to be 70.75 by the MoEF, which represents critical levels of air pollution (score above 60 represents critical levels). Main industries include coal, thermal power stations, steel, paper and cement. Following table gives location and pollutants emitted from these industries.

Five types of industries viz; coal, steel, thermal, cement and paper are present in various blocks in Chandrapur district. During different processes such as drilling, crushing, cokemaking, many gases, chemicals and dust particles are emitted causing air pollution.

According to the Central Pollution Control Board (CPCB), levels of air pollution in Chandrapur district are in the critical zone raising serious concerns of adverse effects on human health. Questions raised by Honourable Members of the Maharashtra Legislative Assembly during the legislative assembly sessions regarding concerns of worsening health of people living in Chandrapur district due to industrial air pollution need to be addressed so that appropriate intervention strategies can be adopted and implemented in the future.

Objectives: This study of assessing health effects was focussed with following objectives –

- ✓ Overall objective:
  - To determine effects of ambient air pollutants on children and adults in Chandrapur district.
- ✓ Specific objectives:
  - Determine prevalence of respiratory symptoms and diseases (asthma, tuberculosis, LRTI/ Pneumonia, Cancer) among children studying in schools in Chandrapur district.
  - Determine prevalence of respiratory symptoms and diseases and cardiovascular health status of adult people living in Chandrapur district.
  - Determine symptoms and diseases for which a patient visits a doctor in Chandrapur district.

Study Design: Comparative cross-sectional study was undertaken in the district with two geographical locations – study and control between August-November 2013. Study location was in the vicinity of industry and control location was more than 25 kms from any of the industries.

Mix method of *Quantitative and Qualitative data collection* was used. Quantitative data included primary data collection from school children, adults and practitioners working in the area. As this was the study of assessing health effects of ambient air pollution, adults working in specified industries were excluded.

To assess the lung function among children, flow meters were used and readings were recorded. Among adults to assess lung function, spirometry was done and readings were recorded. In addition, blood investigations were done for CBC, BSL, Lipid profile, Urea Nitrogen, C - reactive protein and ECG were done on sub-samples.

Secondary data was collated from MPCB for three years to study trend in levels of pollutants they monitor. These pollutants were SO_2, NO_x, SPM and RSPM.

Data from public and industry run hospitals about the patients with different morbidity was collated.

Sample Size: Using the prevalence of Asthma, the sample size was calculated. This gave the sample size of 1000 for children and 1200 for adults. So, this sample was covered from study and equal number was covered from control area as well. Total children samples were 2000 and adult samples were 2400.

Human Resources: Appropriate human resources were deployed for implementing the study. These included public health specialists, clinical specialists, air pollution specialist, social scientists and auxillary nurse midwives.

Data Entry and Analysis: Collected data was entered using epi-info software and then was exported to SPSS for statistical analysis. Appropriate statistical tools and tests were used to compare the results.

Study Findings:

MPCB data analysis: The data for last three years was downloaded from 6 monitoring stations of MPCB - Chandrapur SRO , Chandrapur MIDC, Ballarshah, Tadali MIDC, Ghuggus and Rajura.

Monthly averages were calculated and they were compared with the respective standard value for each of the pollutant.

- For all three years, emission of SO2 and NOx remained below standard[1] values. In the year 2010-11, the levels of emission were higher at all six monitoring sites as compared to later years. The emissions of both these gases are seen reduced in 2012-13, probably due to intervention measures taken by MPCB.

[1]Standard values are taken as per MPCB daily monitoring records of air quality.

- Concentration of RSPM and SPM remained within standard limit at Chandrapur city and MIDC area, whereas at remaining four sites, concentration of these particles is persistently higher than standard value.
- There is a downward trend in pollutant values around September, which could be attributed to monsoons when the pollutant particles settle down quickly.
- Maharashtra Pollution Control Board, Chandrapur, Regional Officer has pointed out similar facts and also added that apart from industries, vehicular emmision and household coal run chulhas contribute particularly more to RSPM and SPM.

Children's Data:

Clinical Manifestations: Wheeze, productive cough and breathlessness are the indicative symptoms for asthma and COPD. Hence, these symptoms were also asked along with other respiratory symptoms such as dry cough, productive cough, etc.

Close to 30% of children had dry cough in study area, the percentage of which in control area was 21.3%. Equal proportion (7.8%) of children in study and control area experienced productive cough in last 1 year. More than 22% of children in study area had night cough in last 1 year, as compared to 13.6 % children in control area. More children in study area (17.8%) experienced continuos sneezing as compared to the children in control area (10.2%). More children in study area (6.8%) had sore throat as compared to the children in control area (3.3%). More children in study area (6.1%) had presence of wheeze as compared to the children in control area (4.4%). More children in study area (6.7%) had chest pain as compared to the children in control area (3.3%). More children in study area (3.2%) experienced breathlessness as compared to the children in control area (1.7%). More children in study area (2%) had asthma as compared to the children in control area (1.2%). Barring a couple of cases in control areas, tuberculosis was not evident. Pneumonia was very low. Only one student in study area had pneumonia in last year.

More than 30% of students residing less than 5 kms from the industry experienced dry cough as compared to students staying at a distance of more than 5 kms from an industry (19.5%). Amongst the students who experienced productive cough, higher percentage (8.7%) were staying at less than 5 kms distance from nearest industry. More number of students were staying at less than 5 kms distance from nearest industry experienced night cough (23.6%) as compared to those students staying at a distance of more than 5 kms from industry (15.1%). Amongst the students who had continuos sneezing, more (19.7%) were staying at less than 5 kms distance from nearest industry. Amongst the students who experienced wheeze, maximum (6.8%) were staying at less than 5 kms distance from nearest industry. Amongst the students who had chest pain, higher proportion (7.5%) of these students were staying at less than 5 kms distance from nearest industry. Amongst the students who experienced sore throat, maximum (7.5%) were staying at less than 5 kms distance from nearest industry. All the students who experienced breatlessness were staying at less than 5 kms distance from nearest industry. Amongst the students who had asthma, maximum were staying at less than 5 kms distance from nearest industry.

Statistically, significant difference is observed in prevalence of following symptoms between study and control groups:

- ✓ Dry Cough: 29.5% in Study and 21.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Night Cough: 22.3% in Study and 13.6% in Control, p=0.000 Significant by Chi Square test
- ✓ Sneezing: 17.8% in Study and 10.2% in Control, p=0.000 Significant by Chi Square test

Statistically, significant difference is observed in prevalence of following symptoms between <= 5 km and > 5km distance

- ✓ Dry Cough: 31.4% in <=5 km and 19.5% in > 5 km, p=0.003 Significant by Chi Square test
- ✓ Night Cough: 23.6% in <=5 km and 15.1% in > 5 km, p=0.018 Significant by Chi Square test
- ✓ Sneezing: 19.1% in <=5 km and 10.7% in > 5 km, p=0.011 Significant by Chi Square test

In both, study and control areas, percentage of children having any respiratory symptom was higher in the age group of 6-7 years, probably due to lower immunity of younger children. The difference observed was statistically significant (p-value by Chi-square= 0.000)

Percentage of male children in study area with presence of any respiratory symptom was slightly higher (53.9%) than the percentage of female children having any respiratory symptom (49.4%). The difference was not statistically significant (p-value by Chi-square=0.157)

There is no significant difference observed in PEFR% result between Study and Control group (p-value by Chi-square= 0.130). This implies that the lung function of children in these two areas is comparable.

However, more than 80% students from study area having not acceptable PEFR% had more illness episodes. Chi-square test for this was not significant.

The prevalence of respiratory symptoms is higher in villages with multiple industries as compared to the villages with single industry. However, in case of village having cement industry, the prevalence is higher irrespective of number of industries present in or near the village.

Adult Data:

To observe the effects of air pollution in different age groups, adults (more than 18 years) were also included in the study. As the study focused on effects of ambient air pollution on health, those working in any of the industries were not included in the study.

Higher % of adults in study area (84.1%) had illness episodes (2-4 times or more than 4 times) compared to control area (78.3%). Higher % of adults in study area (19.4%)

reported dry cough compared to control area (10.3%). Higher % of adults in study area (6.1%) reported productive cough compared to control area (3.0%). Higher % of adults in study area (8.3%) reported night cough compared to control area (6.1%). Higher % of adults in study area (14.6%) reported sneezing compared to control area (6.8%). Higher % of adults in study area (14.1%) reported sore throat compared to control area (5.4%). Higher % of adults in study area (8.0%) reported wheeze compared to control area (1.5%). Higher % of adults in study area (16.0%) reported chest pain / tightness compared to control area (13.2%). Higher % of adults in study area (12.1%) reported breathlessness compared to control area (3.3%). Study area reported 7 cases of LRTI whereas control area reported none. Higher % of adults in study area (7.9%) reported asthma compared to control area (4.2%). Small % of respondents, both in study and control areas reported COPD. Higher % of adults in study area (2.6%) reported IHD compared to control area (0.3%). Higher % of adults in study area (10.9%) reported hypertension compared to control area (6.0%). Higher % of adults in study area (12.9%) had skin problems compared to control area (8.3%). Higher % of adults in study area (14.1%) reported ocular infections compared to control area (8.1%).

Similar % of respondents who stayed less than 5 km or more than 5 km from industry reported presence of dry cough. Higher % (6.4%) of adults in study area who stayed less than 5 kms from industry reported productive cough as compared to adults (4.9%) who stayed at a distance of more than 5 km from industry. Almost similar % of respondents who stayed less than 5 km or more than 5 km from industry reported presence of night cough. Higher % (17.3%) of adults in study area who stayed less than 5 kms from industry reported continuous sneezing as compared to adults (3.8%) who stayed at a distance of more than 5 km from industry. Higher % (16.6%) of adults in study area who stayed less than 5 kms from industry reported sore throat as compared to adults (3.8%) who stayed at a distance of more than 5 km from industry. Higher % (9.7%) of adults in study area who stayed less than 5 kms from industry reported wheeze as compared to adults (1.1%) who stayed at a distance of more than 5 km from industry. Higher % (16.0%) of adults in study area who stayed less than 5 kms from industry reported breathlessness as compared to adults (5.3%) who stayed at a distance of more than 5 km from industry. Higher % (8.9%) of adults in study area who stayed less than 5 kms from industry reported asthma as compared to adults (3.8%) who stayed at a distance of more than 5 km from industry. COPD was negligible in both areas. Higher % (3.0%) of adults in study area who stayed less than 5 km from industry reported IHD as compared to adults (1.1%) who stayed at a distance of more than 5 km from industry. Higher % (12.3%) of adults in study area who stayed less than 5 kms from industry reported hypertension as compared to adults (5.3%) who stayed at a distance of more than 5 km from industry. Higher percentage of all dermatological symptoms was seen in study area as compared to control area.Those who stayed within 5km from industry had higher percentage of dermatological symptoms than those who stayed more than 5km from industry. Higher percentage of ocular infections and eye irritation was seen in study area as compared to control area.

Statistically, significant difference is observed in prevalence of following symptoms between study and control groups:

- ✓ Dry Cough: 19.4% in Study and 10.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Sneezing: 14.6% in Study and 6.8% in Control, p=0.000 Significant by Chi Square test
- ✓ Sore throat: 14.1% in Study and 5.4% in Control, p=0.000 Significant by Chi Square test
- ✓ Breathlessness: 13.9 in Study and 4.7% in Control, p=0.000 Significant by Chi Square test
- ✓ Asthma: 7.9% in Study and 4.2% in Control, p=0.000 Significant by Chi Square test
- ✓ Ischemic heart disease: 2.6% in Study and 0.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Hypertension: 10.6% in Study and 6% in Control, p=0.000 Significant by Chi Square test
- ✓ Skin infections: 6.5% in Study and 3.1% in Control, p=0.000 Significant by Chi Square test
- ✓ Redness/rash: 4.4% in Study and 0.9% in Control, p=0.000 Significant by Chi Square test
- ✓ Skin itch/eczema: 8.1% in Study and 4.6% in Control, p=0.001 Significant by Chi Square test
- ✓ Ulcers: 2.3% in Study and 0.7% in Control, p=0.003 Significant by Chi Square test
- ✓ Ocular infections: 14.1% in Study and 8.1% in Control, p=0.000 Significant by Chi Square test
- ✓ Eye irritation: 26.8% in Study and 15.4% in Control, p=0.000 Significant by Chi Square test

Statistically, significant difference is observed in prevalence of following symptoms between <= 5 km and > 5km distance

- ✓ Sore Throat: 16.6% in <=5 km and 3.8% in > 5 km, p=0.000 Significant by Chi Square test
- ✓ Sneezing: 17.3% in <=5 km and 3.8% in > 5 km, p=0.000 Significant by Chi Square test
- ✓ Wheeze: 9.7% in <=5 km and 1.1% in > 5 km, p=0.000 Significant by Chi Square test
- ✓ Breathlessness: 16.0% in <=5 km and 5.3% in > 5 km, p=0.000 Significant by Chi Square test
- ✓ Hypertension: 12.3% in <=5 km and 5.3% in > 5 km, p=0.001 Significant by Chi Square test
- ✓ Redness/rash: 5.2% in <=5 km and 1.1% in > 5 km, p=0.004 Significant by Chi Square test
- ✓ Skin itch/eczema: : 9.6% in <=5 km and 1.9% in > 5 km, p=0.004 Significant by Chi Square test
- ✓ Ocular infections: 16.9% in <=5 km and 3.0% in > 5 km, p=0.004 Significant by Chi Square test
- ✓ Eye irritation: 31.3 in <=5 km and 9.1% in > 5 km, p=0.004 Significant by Chi Square test

The percentage of people having any respiratory symptom or disease was significantly higher (p-value by Chi-square=0.004) in less than or equal to 45 years age group in both study as well as control area, which shows that the respiratory symptom or disease was associated with air pollution and not because of old age.

Presence of respiratory symptom was more in females as compared to males in both study and control area. The difference was not significant (p-value by Chi-square=0.337).

The prevalence of respiratory symptoms is higher in villages with multiple industries as compared to the villages with single industry. However, in case of village having cement industry, the prevalence is higher irrespective of number of industries present in or near the village.

Findings of spirometry tests in adults:

- ✓ Significant difference is seen between abnormal FEV1/FVC % in study (6.8%) and control area (3.9%).(p-value by Chi-square=0.030)
- ✓ Percentage of abnormal FEV1/FVC% deviation was significantly higher in chest pain, breathlessness and asthma.
- ✓ No significant difference was observed for other symptoms

ECG findings:

ECG results were assessed with the help of two categories - normal and abnormal. Association of these results with area, distance of house from industry and cardiac symptoms was tested. However, none of these showed significant association with ECG results.

Blood Investigations Findings:

Blood tests were carried out with the purpose of assessing effect of air pollution on health with the help of haematological and biochemical blood markers.

Statistically, significant difference was observed in the following parameters, in study and control area-

- ✓ Glucose- 10.17% in study area and 6.57% in control area, p-value by Chi square=0.035
- ✓ Cholesterol- 6.40% in study area and 3.63% in control area, p-value by Chi square=0.010
- ✓ Triglycerides- 20.96%in study area and 13.71% in control area, p-value by Chi square=0.000
- ✓ Bilirubin- 13.94% in study area and 9.50% in control area, p-value by Chi square=0.004
- ✓ C reactive protein- 3.29% in study area and 1.67% in control area, p-value by Chi square=0.036

Findings of data from private practitioners:

The symptoms or diseases reported by practitioners were analysed based on area and distance of house from industry.

Statistically, significant difference is observed in prevalence of following respiratory symptoms between study and control groups:

- ✓ Productive Cough: 11.9% in Study and 7.7% in Control, p=0.001 Significant by Chi Square test
- ✓ Rhinitis: 30.5% in Study and 14.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Sore throat: 14.1% in Study and 5.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Breathlessness: 15.5% in Study and 2.1% in Control, p=0.000 Significant by Chi Square test
- ✓ Eye irritation: 3.8% in study and 1.4% in control, p=0.000 Significant by Chi Square test

For other symptoms, there was no significant difference observed.Similarly, for cardiovascular, dermatological and ophthalmological symptoms, no significant difference was observed.

Statistically, significant difference was observed for rhinitis / nasal irritation for distance between home and industry; 30.2% in less than 5Km and 13.4% in more than 5Km, p=0.004 Significant by Chi Square test.

Comparison with prevalence in other studies:

Prevalence of respiratory symptoms of this study was compared with the prevalence of study sponsored by ICMR - Jindal SK. Indian study on epidemiology of Asthma, Respiratory symptoms and Chronic bronchitis (INSEARCH), September 2010. The INSEARCH study also recorded the prevalence of symptoms, as reported by the respondents, as was done for the current study.

The prevalence of respiratory symptoms are significantly higher in Chandrapur district compared with Nagpur district and national figures.

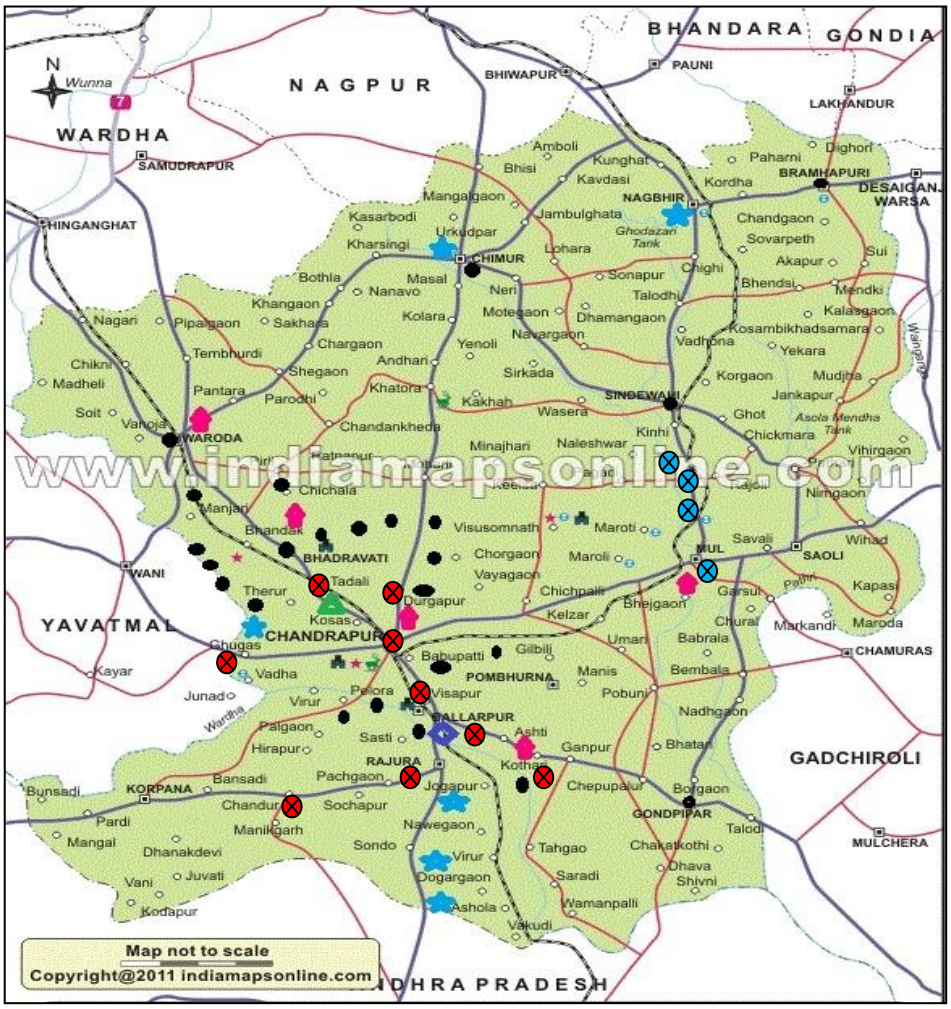
This definitely shows that, the health effects of ambient air pollution are visible at symptomatic level and for Asthma. If necessary steps are not taken at right time, the conditions may worsen.

Recommendations:

Strengthening of source emission monitoring is necessary. Strengthening of air quality monitoring network- Levels of PM2.5, CO and CO2 gases should also be recorded along with the presently monitored SO2, NOx and RSPM as PM2.5 and these gases are also equally harmful to health. Proper mechanism for enforcement and compliance of regulations related to pollution should be built. Sentinel centres should be established by Public Health Department at the health facilities at the location of MPCB monitoring sites. General Hospital Chandrapur will act as ‘Centre of Excellence’ and

the other health facilities at the location of MPCB site will act as satellite centres. These centres will provide promotive, preventive and curative services to local population particularly affected and exposed to air pollutants as well as function as 'Centre for Monitoring' the diseased conditions out of ambient air pollution.

Chandrapur - Industry Spread



- ● - Coal mines
- ⬆ - Thermal station
- ★ - Cement factory
- ▲ - Steel plant
- ◆ - Paper mill
- ⊗ - Study site
- ⊗ - Control site

Chapter 1: Study methodology

Introduction

Chandrapur, earlier called Chanda, is a district in the north-eastern part of Maharashtra and shares its borders with Andhra Pradesh. It has 15 talukas which are spread over an area of 11,443 square kms. The total population of Chandrapur district is 2,194,262 (2011 Census) with a male:female ratio of 1000:959 and a population density of 192 inhabitants/Km^2. The literacy rate is 81.35%.

Fig 1: Location of Chandrapur in Maharashtra

Fig 2: Talukas of Chandrapur District

Apart from its large forest cover and tiger reserve, Chandrapur district has large natural deposits of coal, limestone, high grade iron-ore, bauxite and chromite. Triggered by the infrastructure developed by the Maharashtra Industrial Developmental Corporation (MIDC) in Chandrapur, there has been a tremendous growth in the number of coal, cement and steel industries in Chandrapur over the years which have contributed to the growing economy of the district and the state.[2] There are a total of 6000 small and large scale industries in Chandrapur. Chandrapur city is also called as City of Black Gold because of the large number of coal industries in and around the city. There are a total of 35 coal mines (out of which 7 are in the city), mostly open cast in the city and surrounding areas, over half a dozen coal washeries, one large paper mill, sponge iron units and several cement industries. The Chandrapur Super Thermal Power Station (CSTPS) is one of the biggest thermal power stations in Asia, which is currently generating 2340 MW of electricity.[3]

Fig 3: Coal Mine in Chandrapur

[2]http://envis.maharashtra.gov.in/envis_data/files/Chapter%207.pdf, assessed on 15/10/2013, 10.30AM

[3]Maharashtra Pollution Control Board.Environmental Status and Action Plan for control of pollution at Chandrapur. March 2006.

Industrialization of such a scale has been responsible for very high levels of ambient air pollution in Chandrapur district. According to the Ministry of Environment and Forests (MoEF), Chandrapur is the most polluted city in Maharashtra and the 4th most polluted industrial cluster in India[4] among the 88 key industrial clusters. In terms of Respirable Suspended Particulate Matter (RSPM) pollution, Chandrapur is the most polluted city in India. The Comprehensive Environmental Pollution Index (CEPI) score for Chandrapur's air quality was reported to be 70.75 by the MoEF[5], which represents critical levels of air pollution (score above 60 represents critical levels). Out of the 700 large scale industries in Chandrapur, 150 fall in the Red Zone category. The ambient levels of SO2 in Chandrapur are the third highest in India, and the National Aeronautics and Space Administration (NASA) has already warned of acid rains in Chandrapur in the future.[6]Apart from its harmful effects on vegetation and water quality, high levels of air pollutants emitted from the industries have a significant effect on human health, not only among people working in these industries but also among people living in the vicinity of these industries.[7] High levels of PM10, SO2 and NOx have been associated with adverse respiratory health particularly those associated with airways diseases such as COPD and asthma, and cardiovascular health such as ischemic heart disease, hypertension, systemic inflammation and diabetes mellitus (DM)[8].

Table 3 indicates the hazards of these air pollutants on health and suggested strategies to reduce the emission of these air pollutants.

Table 1: Air pollutants and health effects[9]

Pollutant	Effect on health	Reduction strategies
SO2	Reduced respiratory capacity, inflammation of respiratory tract, aggravation of asthma, eye irritation	Reduction of source emission
NOx	Airway inflammation, reduced lung function, bronchitis in asthmatics	Reduction of source emission
RSPM	Cardiovascular and respiratory diseases including lung cancer,	Reduction of source emission, utilization of fly ash for construction etc, water treatment for settlement of particulate matter on ground

Various studies have shown association between high levels of both gaseous and particulate air pollutants and increased morbidity and mortality due to respiratory and cardiovascular diseases. The exact mechanism though unknown, probable reason for this can be consistent inflammation and hemostasis caused by these pollutants. Continued exposure to these pollutants may lead to synthesis of inflammatory

[4]Central Pollution Control Board.Ministry of Environment and Forests. Comprehensive Environmental Assessmentof Industrial Clusters. December 2009. Table 8 on page 24

[5]Central Pollution Control Board.Ministry of Environment and Forests. Comprehensive Environmental Assessmentof Industrial Clusters. December 2009. Table 8 on page 24

[6]Central Pollution Control Board.Ministry of Environment and Forests. Comprehensive Environmental Assessmentof Industrial Clusters. December 2009. TERI Press, The Energy and Resources Institute, New Delhi.

[7]Maharashtra Pollution Control Board. CEPI Report Nov.2010. Pg No.

[8]http://www.nrdc.org/health/kids/ocar/chap4.asp, Assessed on 25 September 2014, 2.30 pm.

[9]http://www.who.int/mediacentre/factsheets/fs313/en/

biomarkers such as C-reactive protein and also can have impact on normal liver and kidney physiology.[10] Studies have also confirmed that chronic exposure to SO2 may lead to chromosome aberrations (CA), sister chromatid exchanges (SCE) and micronuclei (MN) in peripheral blood lymphocytes and bone marrow depression. (Nemmar et al. 2004; Radomski et al. 2005; Seaton et al. 1995).

There are 2 reported studies[11] that have examined the health status of people living in the industrial areas of Chandrapur district, one by the MoEF and one by the MPCB. The pilot study reported by MoEF was conducted by GMC Nagpur and compared the health status of people living in 2 urban areas (Babupeth and Tikum) with relatively higher levels of ambient air pollution, and one control area (Brahmapuri). They reported no differences in health outcomes between the two study sites. The other study reported by the MPCB was conducted by the District Health Officer, which concluded that the diseases noted by them could not be attributed to air pollution alone and that the effects of air pollution on health needed to be ascertained further. In July 2001, the Bharatiya Adimjati Sevak Sangh along with the District Collector of Chandrapur district conducted a health survey of 3000 people from 5 study villages (villages in the vicinity of industries) and 2 control villages in Chandrapur (villages away from the industries). This study which was funded by the coal mine company (Western Coal Fields Limited) and executed by GMC Nagpur reported no significant variation between control and target population.[11]

According to the Central Pollution Control Board (CPCB), levels of air pollution in Chandrapur district are in the critical zone raising serious concerns of adverse effects on human health. Questions raised by Honourable Members of the Maharashtra Legislative Assembly during the legislative assembly sessions regarding concerns of worsening health of people living in Chandrapur district due to industrial air pollution need to be addressed so that appropriate intervention strategies can be adopted and implemented in the future.[12]

Objectives

✓Overall objective:

- To determine effects of ambient air pollutants on children and adults in Chandrapur district.

✓Specific objectives:

- Determine prevalence of respiratory symptoms and diseases (asthma, tuberculosis, LRTI / Pneumonia, Cancer) among children studying in schools in Chandrapur District.
- Determine prevalence of respiratory symptoms and diseases and cardiovascular health status of adult people living in Chandrapur district.
- Determine symptoms and diseases for which a patient visits a doctor in Chandrapur district.

[10]Rudez et al. Effects of Ambient Air Pollution on Hemostasis and Inflammation. Environmental Health Perspectives .volume 117- number 6. June 2009. Pg.No.995-96.

[11]Ministry of Environment and Forests, Government of India.State of Environment Report.Environment Information System. 2009.

[12]http://articles.timesofindia.indiatimes.com/2009-12-30/nagpur/28062153_1_polluted-city-pollution-levels-comprehensive-environmental-pollution-index.

Study design

1.1 Study period: between August-November 2013

1.2 Mix methodology: Quantitative and Qualitative data collection

1.2.1 Quantitative data included:

1.2.1.1 Primary data:

- ✓ Interviews and diagnostics of target population
  - School children (2000)
    - Epidemiological information by administering strucutred tool (2000)
    - Peak Expiratory Flow Rate through use of Flow Meter (2000)
  - Adult (2400)
    - Epidemiological information by adminstering structured tool (2400)
    - Blood examination- CBC, BSL, Lipid profile, Urea Nitrogen, C-Reactive Protein (2400)
    - Pulmonary function test through Spirometry (1200)
    - ECG (240)
- ✓ Progressive patient data from practitioners
  - 16 practitioners recorded patient data over 45 days (4800)

1.2.1.2 Secondary data (*For period October 2012-September 2013*):

- ✓ Patient data from government hospitals
  - District hospital (1), Sub-district hospital (1) in Mool block, Rural hospitals (3) in Ballapur block, Rajura and Korapana block and Primary Health Centres (9) in Chandrapur block, Ballarpur block and Korapana block and Rajura block.
- ✓ Patient data from industry-run hospitals
  - Western Coal Field Limited in Chandrapur city, Western Coal Field Limited in Durgapur of

Chandrapur block, Ambuja Cement in Gadchandur of Korapana block. Other 3 industries which did not have record included Ballarpur Paper Mill, Chandrapur Super Thermal Power Station and L&T Cement

- ✓ Chandrapur District Pollution Control Board ambient air quality data
    - Data from 6 PCB monitoring sites - Chandrapur city, Chandrapur MIDC, Tadali MIDC, Ghuggus, Ballarpur and Rajura)

1.2.2 Qualitative data included in-depth interviews with:

- ✓ District Pollution Control Board Official (1)
- ✓ District Health Officer (1)
- ✓ Editor of local newspaper (1)
- ✓ Member of Legislative Assembly (1)
- ✓ NGO working in area of pollution/ health (1)

1.3 Sampling

1.3.1 Study sites:

Industrial (study) and non-industrial (control) areas were selected as follows-

- One factory each from power plant, coal mines, cement, paper and steel industry was first identified on the basis of maximal population density within radius of 40 km from the factory in Chandrapur district.
- The selected regions having above factories were subdivided into radius of :
    - ✓ 1-5 km
    - ✓ 5-10 km
    - ✓ 10-20 km
    - ✓ 20-30 km
    - ✓ 30-40 km
    - ✓ >40 km =was included in non-industrial area
- Based on this criteria, the sample was divided in eleven villages in study area and three villages in control area.

- Also, these locations were confirmed on consultation with local health functionaries during meeting held before commencement of field work on 30th July in Chandrapur.

1.3.1.1 Industrial areas

Chandrapur block (5 locations)

- ✓ Durgapur village
- ✓ Sakharwahi village
- ✓ Tadali village
- ✓ Usegaon village
- ✓ Pandharkawda village

Rajura block (1 location)

- ✓ Rajura town

Ballarpur block (4 locations)

- ✓ Ballarshah city
- ✓ Bamni village
- ✓ Kothari village
- ✓ Visapur village

Korpana (1)

- ✓ Gadchandur village

Following table presents the types of industries present in Chandrapur district and the pollutants emitted by these industries-

Table 2: Type of industry and air pollutants emitted[13,14]

Type of industry	Location / block	Function /processes and type of air pollutants emitted
Coal	Chandrapur, Ballarpur, Rajura	drilling, crushing, screening, blasting, coal washing- dust, NOx, SO2, CO, SPM
Steel	Chandrapur	Cokemaking - coke oven gas, naphthalene, ammonium compounds, NOx, sulphur and coke dust Ironmaking- Sulphur dioxide and hydrogen sulphide
Cement	Chandrapur, Korapana, Rajura	Pet coke or coal- PM2.5, PM10, SO2, NOx, Calcinations- CO2 and CO
Paper	Ballarpur	SPM, H2S, SO2, CO, Chloroform
Thermal	Chandrapur	SO2, NOx, CO2

1.3.2 Control site

1.3.2.1 Areas free of industry (Control)

Mul (3)

- ✓ Chikhali village
- ✓ Dongargaon village
- ✓ Rajoli village

It was found that the Mul block which is control area for the study has a considerable number of rice mills, oil mills and poha mills. Number of mills in the villages in control group from where data is collected is presented in the following table:

Table 3: Number of mills in control area

Sr. No.	Name of village	Type of industry			
		Rice mill	Oil mill	Poha mill	Power company
1	Rajoli	6	-	-	-
2	Chikhali	1	-	-	-

Huge amount of dust or particulate matter is generated in cleaning and milling sections in a rice mill.[15] However, there is no mechanism to measure the amount of emitted

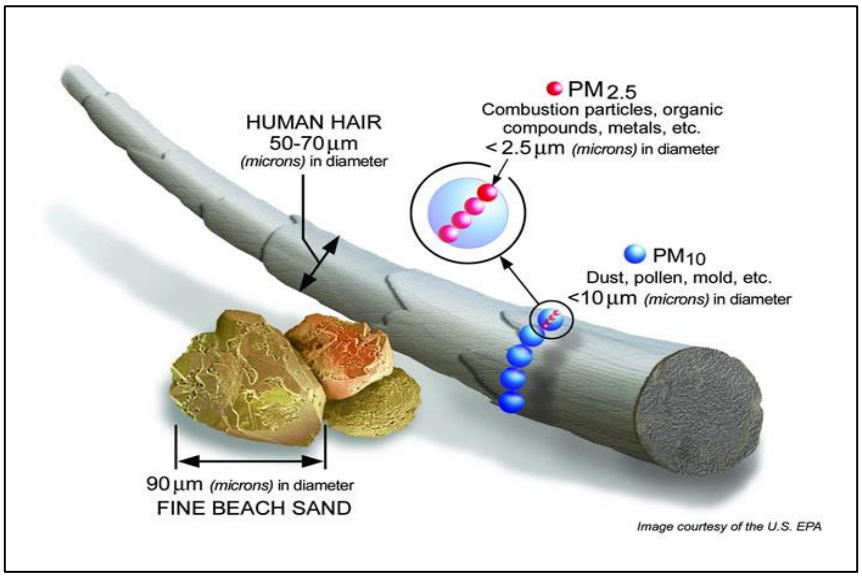
[13]Sharma AK, Siddiqui KA: Analysis of air pollution problem around open cast coal mine and its impact on vegetation. Indian J.Sci.Res.1(2):47-55,2010

[14]Atimtay AT and Chaudhary M. T: Air Pollution Due To NOx Emissions In An Iron-Steel Industry Region In South-Eastern Turkey And Emission Reductionstrategies. downloaded from: http://www.umad.de/infos/cleanair13/pdf/full_152.pdf on 12/2/2013, 10.23 AM

particulate matter. Additionally, the MPCB pollution monitoring site is not established at Mul block. Therefore, effect of air pollution caused due to rice mills on the health of people in this block cannot be measured.

1.3.3 Ambient air pollutants considered in this study as per MPCB monitoring system included:

- ✓ SO2= Sulphur Dioxide
- ✓ NOx= Mono-nitrogen oxides (Nitric Oxide and Nitrogen Dioxide)
- ✓ RSPM= Respirable Suspended Particulate Matter (PM 10)
- ✓ SPM= Suspended Particulate Matter
    - Below Picture 1 shows how big is the pollution particle



Picture 1: Pollution Particle

[15]Central Pollution Control Board.Comprehensive Industry Document On Pulse, Wheat, Rice Mills.July 2008. Pg.No. 27-29.

1.3.4 Following Matrix 1 provides at a glance block and village wise distribution of industries

Matrix 1: Block and Village wise distribution of Industires

Sr. No.	Name of block	Name of village/city	Type of industry in the village / vicinity
1.	Ballarpur	Visapur	Coal
2.	Ballarpur	Kothari	Coal
3.	Ballarpur	Ballarpur	Coal, Paper
4.	Ballarpur	Bamani	Coal, Paper
5.	Chandrapur	Chandrapur	Coal, Steel, Thermal
6.	Chandrapur	Durgapur	Coal, Steel, Thermal
7.	Chandrapur	Tadali	Coal, Thermal
8.	Chandrapur	Sakharwahi	Coal, Cement
9.	Chandrapur	Pandharkawda	Coal
10.	Chandrapur	Usegaon	Coal
11.	Korapana	Gadchandur	Cement
12.	Rajura	Rajura	Cement, Coal

1.4 Sample-size

The sample size was determined for school children and adult population upon considering lowest prevalence of respiratory disease. Asthma being the lowest prevalent respiratory disease, its respective prevalence value for children and adults was taken as 'P' in sample size calculation. Considering this also meant coverage of larger population and other diseases.

Thus, prevalence of asthma for children and adult population is considered for respective sample size calculation.

1.4.1 Sample for children

Prevalence of asthma for this age group is 4.5% as per the ISAAC study. This is taken as p in the sample size formula.

$$\text{Sample size } n = \frac{4 * p * q}{L * L}$$

Where, p = prevalence of disease

q = 1 – p

L = allowable error in p = taken as 30% of p

Putting the values in this formula we get, sample size = n = 943.

This was rounded to 1000.

Total sample (School children)= 2000(1000 from study and 1000 from control)

1.4.1.1 Children sample distribution for epidemiological information and diagnostics

- ✓ Epidemiological information= 2000
- ✓ PEFR by using flow meter= 2000
- ✓ Sampling strategy- five each from private and government schools were randomly selected from study area and same number from control area. From each school, fifty students each of age 6-7 years and age 13-14 years were selected randomly.

To observe the effect of air pollution by age / exposed years, children of younger age (from primary school) and older age (secondary shool) were selected.

1.4.2 Sample for adults

Prevalence of this age group is 2.4% as per the ICMR study. For this group L is taken as 40% of p to allow more variation.

$$\text{Sample size } n = \frac{4 * p * q}{L * L}$$

Where, p = prevalence of disease

q = 1 – p

L = allowable error in p = taken as 40% of p

Using the above formula, we get the sample size, n = 1017.

This group had to undergo the blood investigations, the drop-out rate of 10% was considered and sample size was 1118 by adding 10%.

This was rounded to 1200.

Total sample (Adults)= 2400(1200 from Study and 1200 from Control)

1.4.2.1 Adult sample distribution for epidemiological information and diagnostics

- ✓ Epidemiological information= 2400
- ✓ Blood examination= 2400
- ✓ Lung Function Test through Spirometry= 1200
- ✓ ECG= 240
- ✓ Sampling strategy- From every alternate household one female and one elderly male (both not working in industry) were selected for the study.

In industrial area, to see the effect of ambient air, the persons working in any of the industry were excluded.

1.4.3 Sample for patients from practitioners

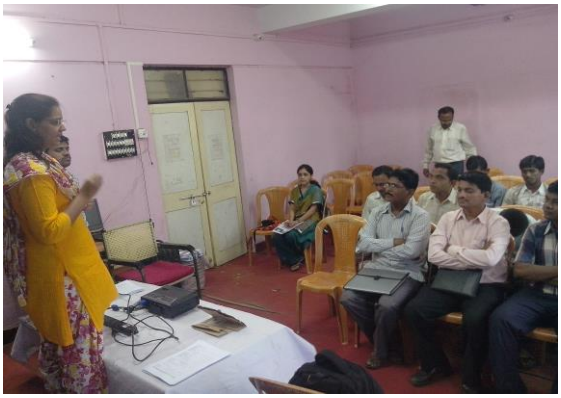
From each of the study and control area, 10 practitioners were identified who showed willingness to participate. Each of the practitioners shared the data of their patients for a period of 45 days.

Total seventeen of twenty identified practioners participated in this study and recorded information of patients based on the tool provided.

Total patient sample achieved = 4800

1.5 Data collection-

Training of all the data collectors was conducted prior to commencement of data collection. Data was collected in the following manner:



1.5.1 School children's epidemiological data- A structured questionnaire was filled by a group of social scientists, by asking questions to students. Students were asked questions regarding their demographic details, clinical manifestations that is number of illness episodes in last one year, presence of illness at the time of study and presence of respiratory illness. Height and weight of students was measured. Teachers' help was taken for the questions such as attendance or performance of child.

1.5.2 School children's diagnostics- Flowmetries were conducted using RMS Helios flowmeters by social scientists. Each child was given instructions on how to perform the flowmetry before the test. The test was carried out in standing position. Every child was asked to perform the test five times and the best reading was recorded.

1.5.3 Adult epidemiological data and blood-

- ✓ Auxillary Nursing Midwives (ANMs) or Lady Health Visitors (LHVs) of the primary health centre/sub-centre present in the village collected the epidemiological data using a structured tool. Questions related to demographic profile, clinical manifestations including number of illness episodes in last one year, type of illness, system wise presence of

symptoms at the time of study were asked. Height and weight of each participant was measured.

- ✓ Blood was collected by ANMs/LHVs in three types of tubes, using vacutainer method. Plain bulbs were used for biochemistry tests, EDTA bulbs for haematological tests and fluoride bulbs for blood glucose test. Blood tests were conducted at the pathology laboratory of General Hospital, Chandrapur, by pathologist and two laboratory technicians.

1.5.4 Adult spirometry data- Fifty per cent of the sample was taken for lung function assessment. These participants were selected by taking every alternate participant from large sample. Spirometry was conducted by social scientists with prior training. RMS Helios 3.1.85 spirometers were used, which were calibrated everyday before use. The respondent was explained the procedure and then asked to perform the spirometry test five times. Best of these five readings were recorded.

1.5.5 Adult ECGs- ECGs of 10 per cent sample were conducted by an ECG technician and one female assistant, at the PHC or sub-centre. These participants were selected by systematic random sampling method from the larger sample.

1.5.6 Progressive data of clinics- Data from patients attending private clinics was recorded with the help of sixteen practitioners from the study as well as control area.

1.5.7 Secondary data-

- ✓ Data of emission levels of air pollutants for the period October 2010- September 2013 was downloaded from the website of Maharashtra Pollution Control Board.

Following table shows the overall sample distribution of primary data and patients' progressive data from private clinics.

Table 4: Sample distribution of data

Name of village	school children epidemiological	Flowmetry	adult epidemiological	Spirometry	ECG	Blood	Patients' data at Private clinics
Study:							
Durgapur (200)	200	200	225	113	23	225	300
Tadali (133)	133	133	150	78	17	150	690
Sakharwahi(133)	133	133	150	75	15	150	
Urjagram (135)	135	135					
Usegaon (100)	100	100	113	57	13	109	
Pandharkawada (100)	100	100	113	57	13	113	170
Visapur (36)	36	36	80	40	8	78	150
Kothari (36)	36	36	80	40	10	80	300
Bamni (40)	40	40	100	50	10	98	220
Ballarpur (40)	40	40	100	51	10	100	
Rajura (25)	25	25	150	75	15	150	300
Gadchandur (25)	25	25	120	61	12	119	120
Control:							
Rajoli (333)	333	333	340	170	37	340	3330
Dongargaon (333)	333	333	340	172	33	340	
Chikhali (335)	335	335	341	171	34	340	530
Total	2004	2004	2402	1210	250	2392	6110

1.6 Analysis

1.6.1 Statistical analysis of collected quantitative primary and secondary data was done using statistical software SPSS Statistics 17.0. The analysis included:

1.6.1.1 Descriptive statistics

1.6.1.2 Inferential statistics

1.6.1.3 Application of Test of Significance

1.7 Human resource and roles

Sr. No.	Position	Number	Name	Expertise	Role
1.	Project Leader (Principal Investigator)	1	Dr. A Ladda	Public Health Expert	Overall monitoring of the study; Liaison with client; Finalization of tools; Qualitative interviews; Report writing
2.	Project Advisor	1	Dr. Abhijit Khanvilkar	Health Management, Planning and Policy	Advise on study design, execution, report preparation, dissemination of findings and policy recommendation
3.	Project manager	1	Ms. Aruna Deshpande	Statistics and Public Health Research	Overall coordination; Liaison with all data collectors and report to Project Leader
4.	Technical Specialist - Health	1	Dr. Gauri Godbole	MD Chest	Inputs on clinical correlations of air pollution and health; analysis of reports of flow meter & spirometry; inputs on tools development to capture CVS and pulmonary health profile; inputs on reports writing and recommendations
5.	Technical Specialist - Air	1	Dr. A Ojha	Air Pollution Expert	Inputs on sampling; inputs on tools development; application of specific model for analysis; inputs on reports writing and recommendations
6.	Technical Specialist – CVS	1	Dr. Arjun Kakrani	MD Medicine	Inputs on clinical correlations of air pollution and health; analysis of reports of blood tests and ECG; inputs on tools development to capture CVS and Pulmonary health profile; inputs on reports writing and recommendations
7.	Technical Specialist – Public Health	1	Dr. Vandana Kakrani	MD PSM	Inputs on clinical correlations of air pollution and health; inputs on tools development, reports writing and recommendations
8.	Coordinator	1	Dr. N. M. Rathi	PG qualifications in PSM	Coordination at Chandrapur – with all stakeholders from government and private
9.	Supervisor	5	Ms. Charuta Gokhale	Post Graduate in	Supervision of field work to ensure quality of data

Sr. No.	Position	Number	Name	Expertise	Role
10.	Supervisor		Dr. Leena Gaikwad	Public Health	
11.	Supervisor		Dr. Dhananjay Pathak		
12.	Supervisor		Dr. Monica Malpani		
13.	Supervisor		Dr. Aditi Agashe		
14.	Field Investigator	6	SC – ANMs were deployed	ANM	Drawing blood sample; spirometry; anthropometric measurements; BP of target group at house hold level
15.	Field Investigator	11	List provided separately	MSW	School level data collection including anthropometric measurements and flow meter application and recording the findings; administering tool at HH level
16.	Lab Technican	1	Tie up with DH		Blood testing of target population at DH
17.	Statistical Expertise	1	Ms. Aruna Deshpande	Research & Statistics	Data management & analysis

Chapter 2: Finding of Maharashtra Pollution Control Board (MPCB) data

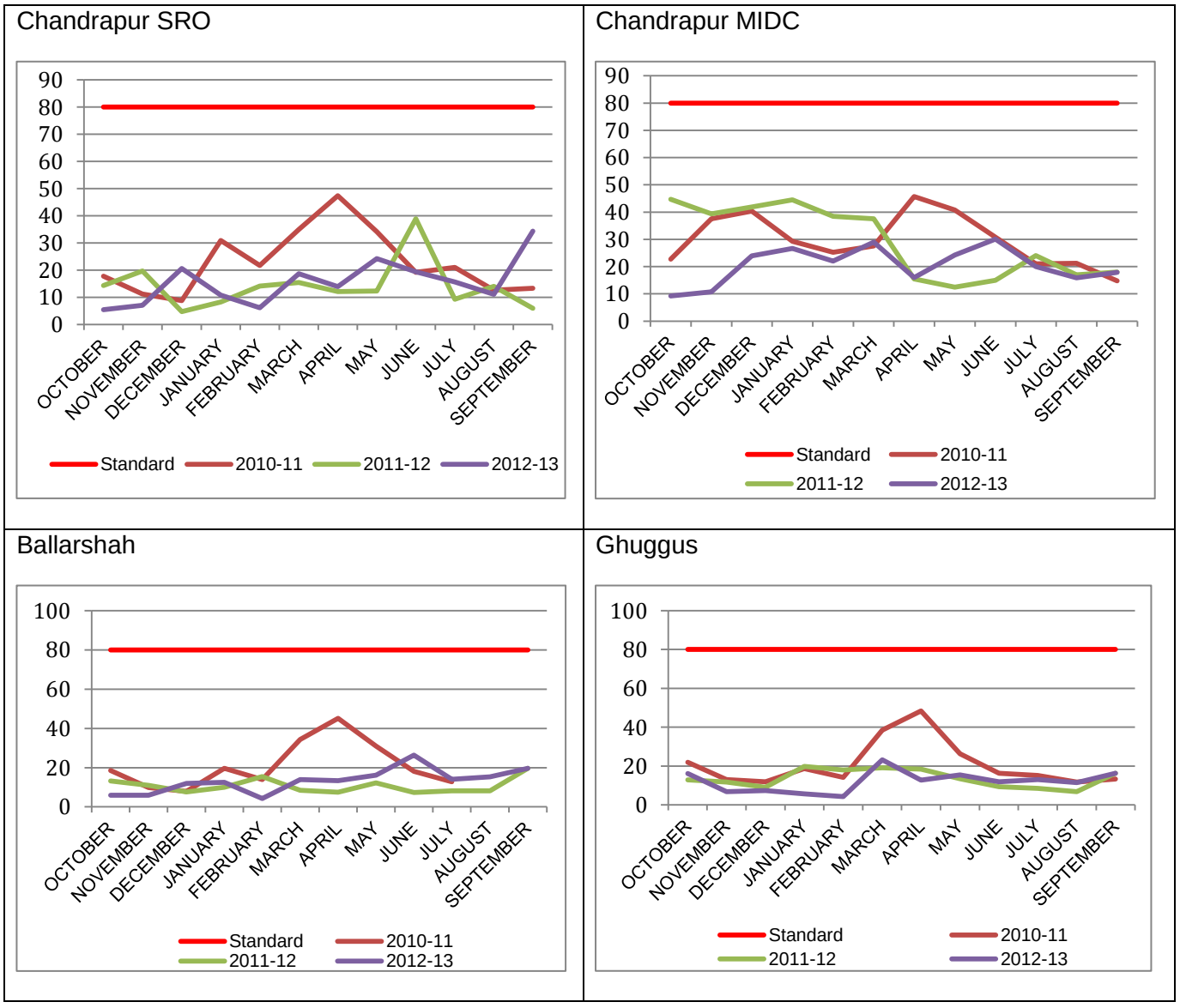
Pollutant wise scenario

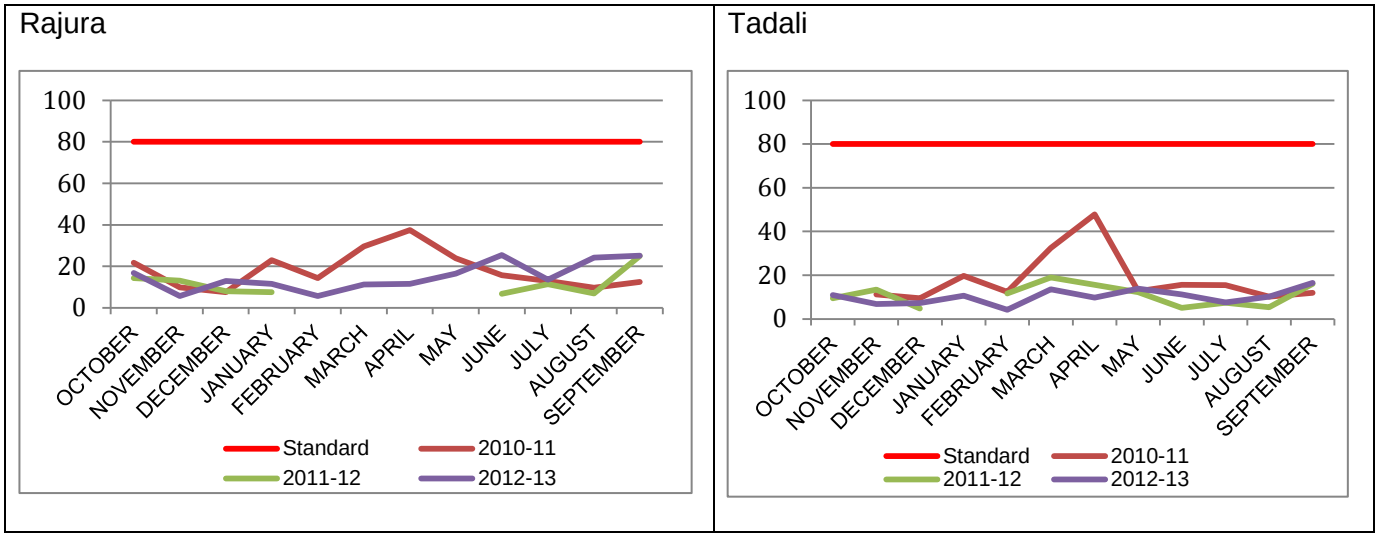
Daily monitored data over the last three years (October 2010 to September 2013) at six monitoring sites of MPCB was analysed. For each of the pollutant, standard value is given at the MPCB site which is considered as critical level by MPCB.

Following graphs present scenario of pollutants as monitored by MPCB over the last three years.

Emission of Sulpher Diaoxide(SO2) in comparison with a standard value = 80

Figure 1: Site wise concentration of SO_2 in ambient air

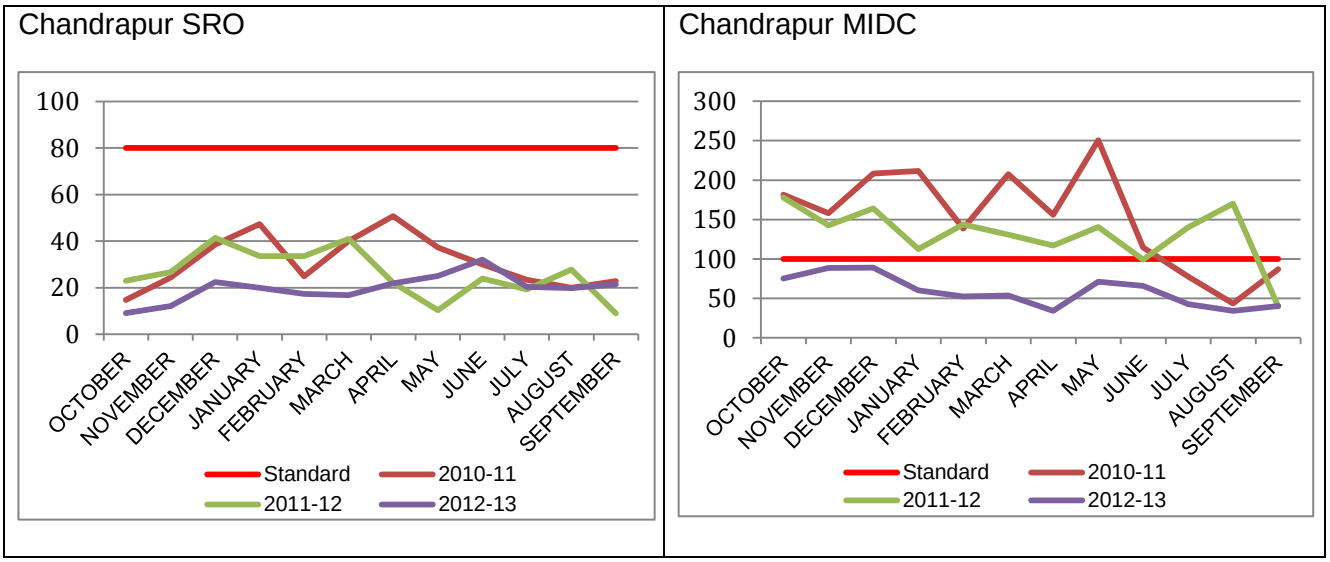




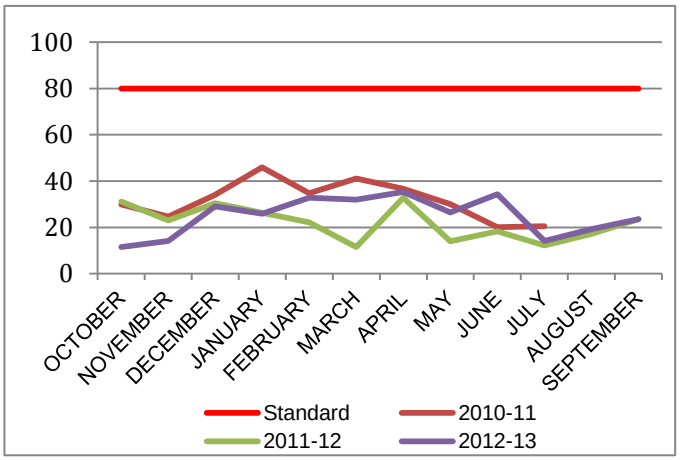
For all three years, emission of SO2 remained within standard value. In the year 2010-11, the levels of emission were higher at all six monitoring sites as compared to later years. The emissions are seen reduced in 2012-13, probably due to intervention measures taken by MPCB.

Emission of Nitrogen Oxide in comparison with a standard value = 80

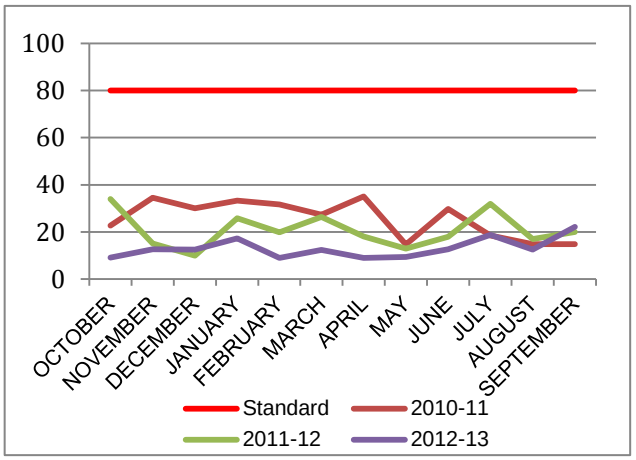
Figure 2: Site wise concentration of NOx in ambient air



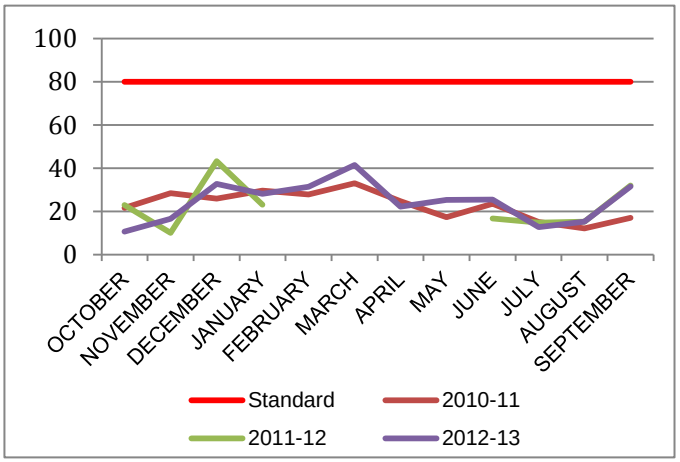
Ballarshah



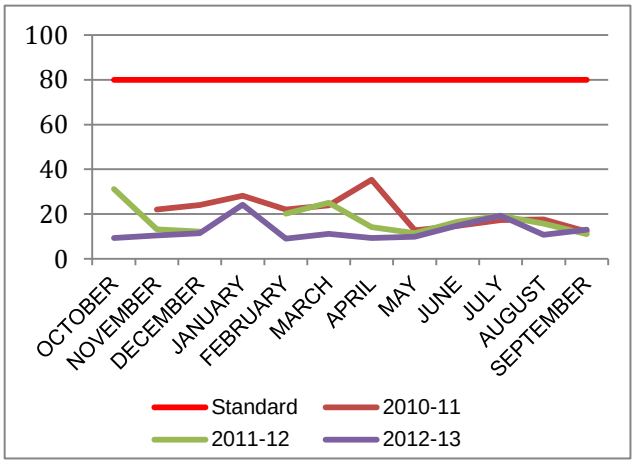
Ghuggus



Rajura



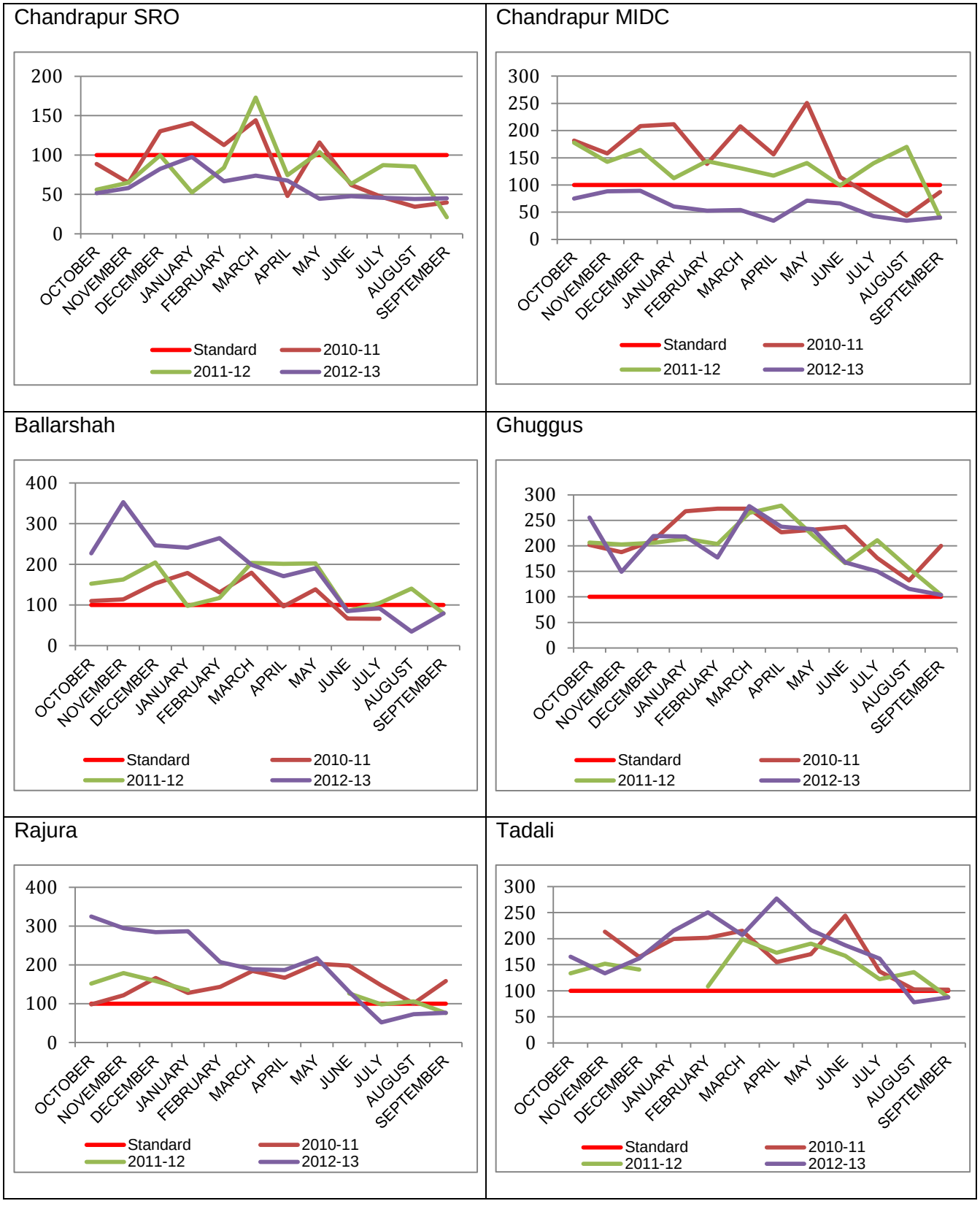
Tadali



Emission of NOx is within standard values in all three years. In the year 2012-13, the values are lowest at Chandrapur SRO, Chandrapur MIDC, Ghuggus and Tadali, whereas at other two sites, the emission values are higher than the previous year 2011-12.

Emission of Respirable Suspended Particulate Matter(RSPM) in comparison with a standard value = 100

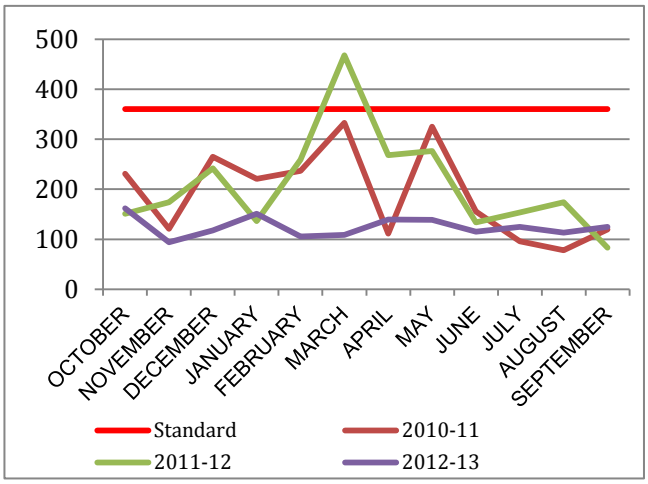
Figure 3: Site wise concentration of RSPM in ambient air



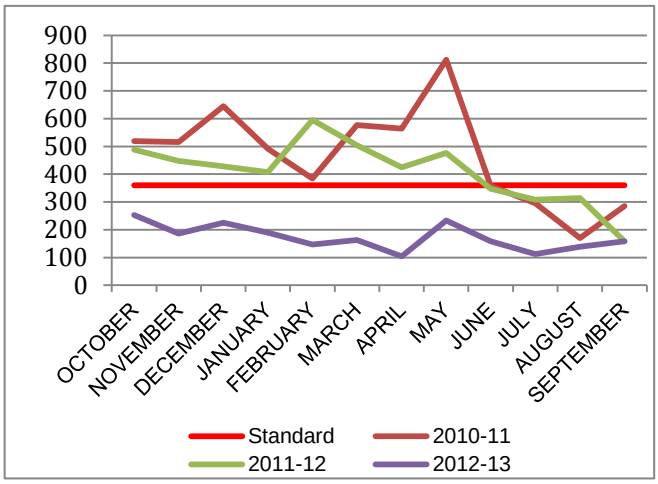
Emission of Suspended Particulate Matter (SPM)**in comparison with a standard value = 360**

Figure 4: Site wise concentration of SPM in ambient air

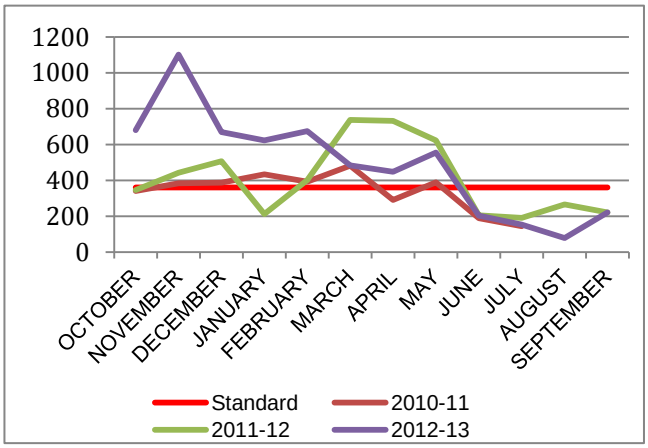
Chandrapur SRO



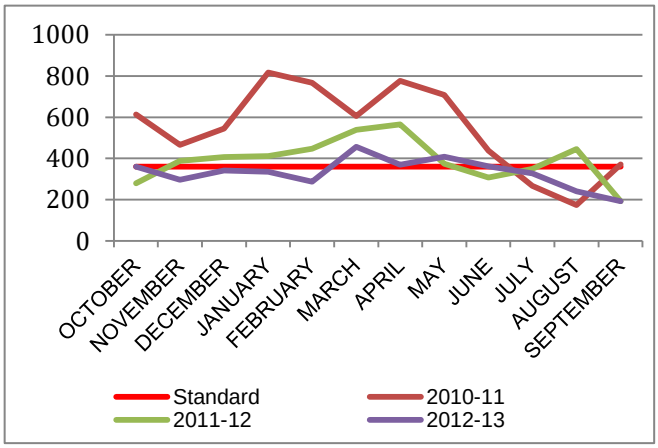
Chandrapur MIDC



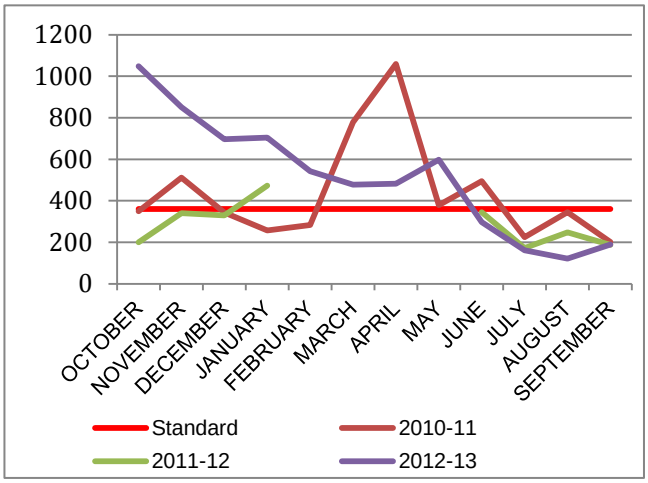
Ballarshah



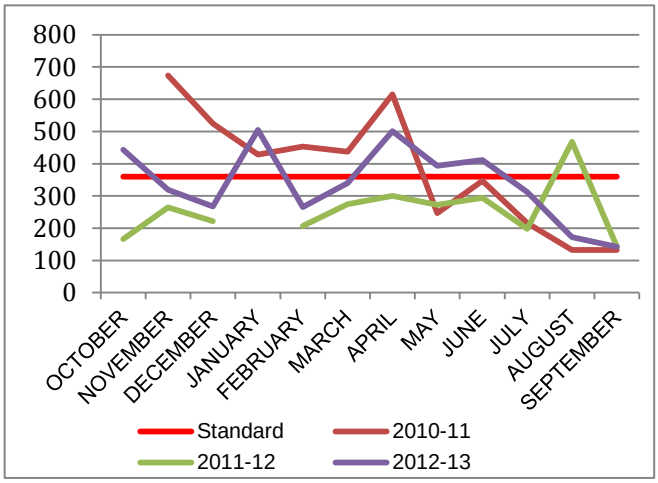
Ghuggus



Rajura



Tadali



Concentration of RSPM and SPM remained within standard values at Chandrapur city and MIDC area, **whereas at remaining four sites concentration of these particles is persistently higher than normal**. Figures 3 and 4 confirm high concentration of RSPM and SPM at 4 MPCB monitoring sites for the period October 2012 to September 2013.

There is a downward trend in values which could be attributed to monsoons when the pollutant particles settle down quickly.

Chandrapur District Pollution Control Board Regional Officer has pointed out similar facts and also added that apart from industries, vehicular emmision and household coal run chulhas contribute particularly more to RSPM and SPM.

Chapter 3: Finding of school children epidemiological data

School children in the age group 6-7 years and 13-14 years were selected with the purpose of observing effects of ambient air pollution at different age groups (at young age and comparatively older age). From both the areas (study and control); 1001 children were covered in the sample. Findings are presented below. Sample size n may vary in tables because of the responses available for that particular question.

Age and gender wise distribution of sample in study and control area is presented in following tables-

Table 5: Age wise distribution of sample

Age group	Statistics	Area	
		Study	Control
6-7	Count	604	606
	%	60.3%	60.5%
13-14	Count	397	395
	%	39.7%	39.5%
Total	Count	1001	1001
	%	100.0%	100.0%

The age group wise percentage of school children in study and control area was similar.

Table 6: sex wise distribution of sample

Sex	Statistics	Area	
		Study	Control
Male	Count	505	490
	%	50.4%	49.0%
Female	Count	496	511
	%	49.6%	51.0%
Total	Count	1001	1001
	%	100.0%	100.0%

The sex wise percentage of children in study and control area was almost similar.

Table 7: Mean BMI with respect to area

area	Study(n=1001)	Control(n=999)
Mean	14.1	14.2
Std. Deviation	2.3	2.3

The table above shows that the mean BMI of children in both study and control area was similar at the time of study. Hence, the clinical parameters of these two groups are comparable.

Clinical manifestations-

Following tables present clinical manifestations amongst school children from study and control areas and also the association of clinical manifestations amongst school children from study with respect to distance of their home from nearest industry.

Table 8: Illness episode

Parameter	Response	Statistics	Area		Total
			Study	Control	
Illness episode in last 1 year	Never	Count	159	177	336
		%	15.9%	17.7%	16.8%
	2-4 times	Count	735	713	1448
		%	73.5%	71.2%	72.4%
	More than 4 times	Count	106	111	217
		%	10.6%	11.1%	10.8%
Total		N=	1000	1001	2001

More than 70% of children from both, study and control sites had an episode of illness 2-4 times in last 1 year. Also, more than 10% of children from both sites has more than 4 episodes of illness in last 1 year.

Wheeze, productive cough, night cough and breathlessness are the indicative symptoms for asthma and COPD. Hence, these symptoms were asked along with other respiratory symptoms such as dry cough, sore throat, etc. Following table presents the presence of respiratory symptoms in study and control area as well as with respect to distance of home from nearest industry.

Table 9: Presence of Respiratory Symptoms& Diseases

Symptom/ disease	Area					Distance between home and industry within Study Group				
	Study		Control		Statistical Test result (p-value)	<5km		>=5km		Statistical Test result (p-value)
	n=1001		n=1001			n=842		n=159		
	Number	Percentage	Number	Percentage		Number	Percentage	Number	Percentage	
Respiratory System										
Dry Cough	295	29.5	213	21.3	0.000 Significant	264	31.4	31	19.5	0.003 Significant
Productive Cough	78	7.8	78	7.8	-	73	8.7	5	3.1	0.017 Significant
Night Cough	223	22.3	136	13.6	0.000 Significant	199	23.6	24	15.1	0.018 Significant
Continuous Sneezing	178	17.8	102	10.2	0.000 Significant	161	19.1	17	10.7	0.011 Significant
Sore Throat	68	6.8	33	3.3	0.000 Significant	63	7.5	5	3.1	0.046 Significant
Wheeze	61	6.1	44	4.4	0.087 Not Significant	57	6.8	4	2.5	0.039 Significant
Chest Pain	67	6.7	33	3.3	0.000 Significant	63	7.5	4	2.5	0.022 Significant
Foreign Bodies in respiratory tract	17	1.7	12	1.2	0.350 Not Significant	12	1.4	5	3.1	0.124 Not Significant
Breathlessness	32	3.2	7	0.7	0.000 Significant	32	3.8	0	0	-
Asthma	20	2	12	1.2	0.154 Not Significant	19	2.3	1	0.6	0.179
Tuberculosis	0	0	2	0.02	-	0		0		-
LRTI - Pneumonia	1	0.1	0	0	-	1		0		-

Figure 5: Prevalence of Respiratory Symptoms among Children in Study and Control Area

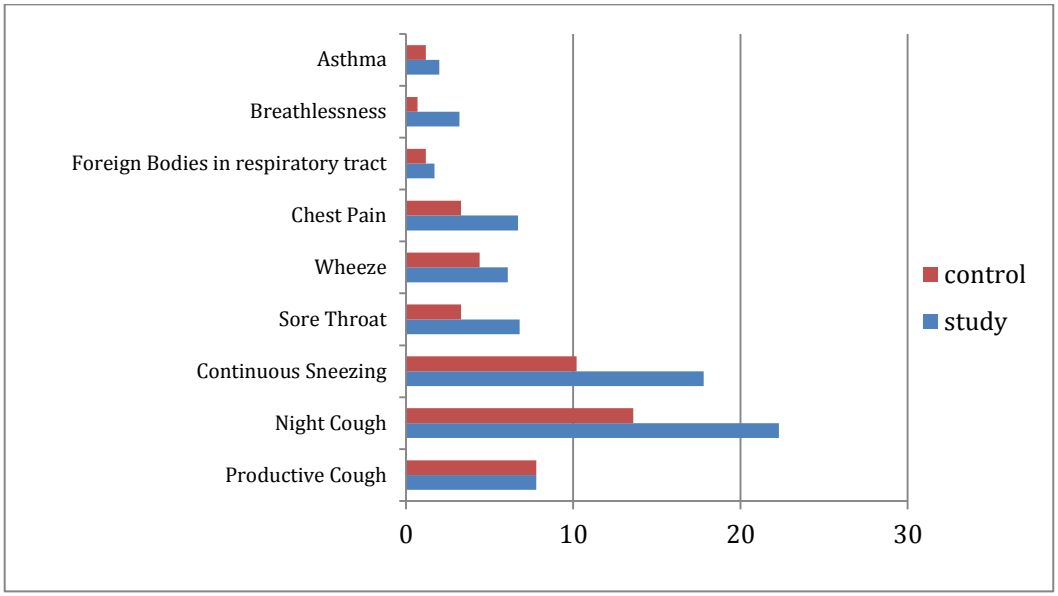
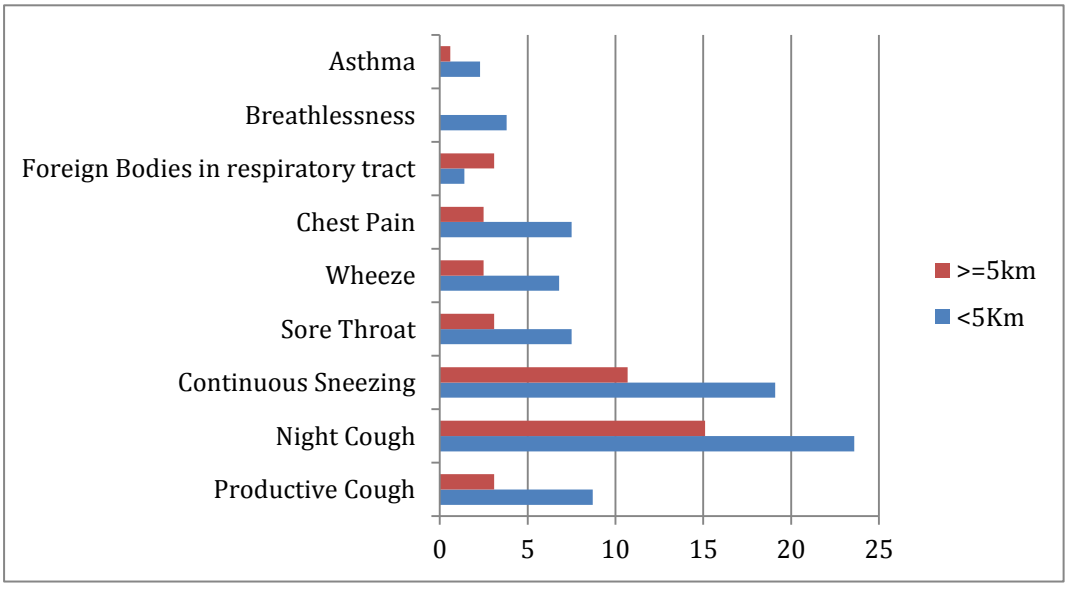


Figure 6: Prevalence of Respiratory Symptoms among Children in Study Area with respect to distance



Close to 30% of children had dry cough in study area, the percentage of which in control area was 21.3%. Equal proportion (7.8%) of children in study and control area experienced productive cough in last 1 year. More than 22% of children in study area had night cough in last 1 year, as compared to 13.6 % children in control area. More children in study area (17.8%) experienced continuous sneezing as compared to the children in control area (10.2%). More children in study area (6.8%) had sore throat as compared to the children in control area (3.3%). More children in study area (6.1%) had presence of wheeze as compared to the children in control area (4.4%). More children in study area (6.7%) had chest pain as compared to the children in control area (3.3%). More children in study area (3.2%) experienced breathlessness as compared to the children in control area (1.7%). More children in study area (2%) had asthma as compared to the children in control area (1.2%). Barring a couple of cases

in control areas, tuberculosis was not evident. Pneumonia was very low. Only one student in study area had pneumonia in last year.

More than 30% of students residing less than 5 kms from the industry experienced dry cough as compared to students staying at a distance of more than 5 kms away from an industry (19.5%). Amongst the students who experienced productive cough higher percentage (8.7%) were staying at less than 5 kms distance from nearest industry. More number of students were staying at less than 5 kms distance from nearest industry experienced night cough (23.6%) as compared to those students staying at a distance of more than 5 kms from industry (15.1%). Amongst the students who had continuos sneezing, more (19.7%) were staying at less than 5 kms distance from nearest industry. Amongst the students who experienced wheeze, maximum (6.8%) were staying at less than 5 kms distance from nearest industry. Amongst the students who had chest pain, higher proportion (7.5%) of these students were staying at less than 5 kms distance from nearest industry. Amongst the students who experienced sore throat maximum (7.5%) were staying at less than 5 kms distance from nearest industry. The students who experienced breatlessness were staying at less than 5 kms distance from nearest industry. Amongst the students who had asthma, maximum were staying at less than 5 kms distance from nearest industry.

1.1 Statistically significant difference is observed in prevalence of following symptoms between study and control groups:

- ✓ Dry Cough: 29.5% in Study and 21.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Night Cough: 22.3% in Study and 13.6% in Control, p=0.000 Significant by Chi Square test
- ✓ Sneezing: 17.8% in Study and 10.2% in Control, p=0.000 Significant by Chi Square test

1.2 Statistically significant difference is observed in prevalence of following symptoms between <= 5 km and > 5km distance

- ✓ Dry Cough: 31.4% in <=5 km and 19.5% in > 5 km, p=0.003 Significant by Chi Square test
- ✓ Night Cough: 23.6% in <=5 km and 15.1% in > 5 km, p=0.018 Significant by Chi Square test
- ✓ Sneezing: 19.1% in <=5 km and 10.7% in > 5 km, p=0.011 Significant by Chi Square test

Age and sex wise distribution of children having any respiratory symptoms in study and control area was also assessed and is presented in following table-

Table 10: Age wise distribution of presence of any respiratory symptom

Age group	Statistics	Study	Control
6-7 years	Count	346	262
	%	66.9%	69.3%
13-14 years	Count	171	116
	%	33.1%	30.7%
Total	Count	517	378
	%	100.0%	100.0%

In both study and control areas, percentage of children having any respiratory symptoms was higher in the age group of 6-7 years, probably due to lower immunity of younger children. The difference observed was statistically significant (p-value by Chi-square= 0.000)

Table 11: Sex wise distribution of presence of any respiratory symptom

Sex	Statistics	Study	Control
Male	Count	272	188
	%	53.9%	38.4%
Female	Count	245	190
	%	49.4%	37.2%
Total	Count	517	378
	%	51.6%	37.8%

Percentage of male children in study area with presence of any respiratory symptom was slightly higher (53.9%) than the percentage of female children having any respiratory symptom (49.4%). The difference was not statistically significant (p-value by Chi-square=0.157).

2.Village wise prevalence of symptoms

The respiratory symptoms reported by school children in the study area were also assessed with respect to presence of industry in or near village.

Table 12: Villagewise prevalence of respiratory symptoms

Name Of Village	Type of industry	Statistics	Symptoms							
			Dry Cough	Productive Cough	Night Cough	Cont. Sneezing	Sore Throat	Wheeze	Breathlessness	Asthma
Ballarpur	Coal, paper	Count	27	4	25	11	5	2	0	0
		% within Name of the village	67.5%	10.0%	62.5%	27.5%	12.5%	5.0%	.0%	.0%
Bamni	Coal, paper	Count	20	1	16	6	3	1	1	1
		% within Name of the village	50.0%	2.5%	40.0%	15.0%	7.5%	2.5%	2.5%	2.5%
Durgapur	Coal, steel, thermal	Count	64	16	36	41	23	6	2	2
		% within Name of the village	32.0%	8.0%	18.0%	20.5%	11.6%	3.0%	1.0%	1.0%
Gadchandur	Cement	Count	15	1	15	4	1	0	0	0
		% within Name of the village	60.0%	4.0%	60.0%	16.0%	4.0%	.0%	.0%	.0%
Kothari	Coal, cement	Count	15	3	13	8	3	2	0	1
		% within Name of the village	41.7%	8.3%	36.1%	22.2%	8.3%	5.6%	.0%	2.8%
Pandharkavda	Coal	Count	6	0	5	4	0	1	0	0
		% within Name of the village	6.0%	.0%	5.0%	4.0%	.0%	1.0%	.0%	.0%
Rajura	Cement, Coal	Count	13	2	9	4	3	0	0	0

Name Of Village	Type of industry	Statistics	Symptoms							
			Dry Cough	Productive Cough	Night Cough	Cont. Sneezing	Sore Throat	Wheeze	Breathlessness	Asthma
		% within Name of the village	52.0%	8.0%	36.0%	16.0%	12.0%	.0%	.0%	.0%
Sakharwahi	Coal, cement	Count	37	10	29	15	6	8	18	2
		% within Name of the village	27.8%	7.5%	21.8%	11.3%	4.5%	6.0%	13.5%	1.5%
Tadali	Coal, thermal	Count	24	5	20	35	3	8	7	1
		% within Name of the village	18.0%	3.8%	15.0%	26.3%	2.3%	6.0%	5.3%	.8%
Urjanagar	Coal, Steel, Thermal	Count	44	20	33	25	10	27	2	6
		% within Name of the village	33.3%	15.2%	25.0%	18.9%	7.6%	20.5%	1.5%	4.5%
Usegaon	Coal	Count	27	16	22	24	11	6	2	7
		% within Name of the village	27.0%	16.0%	22.0%	24.0%	11.0%	6.0%	2.0%	7.0%

From the table above, it can be seen that the prevalence of respiratory symptoms is higher in villages with multiple industries as compared to the villages with single industry. However, in case of village having cement industry, the prevalence is higher irrespective of number of industries present in or near the village.

Chapter 4: Finding of school children diagnostic test

Diagnostic findings

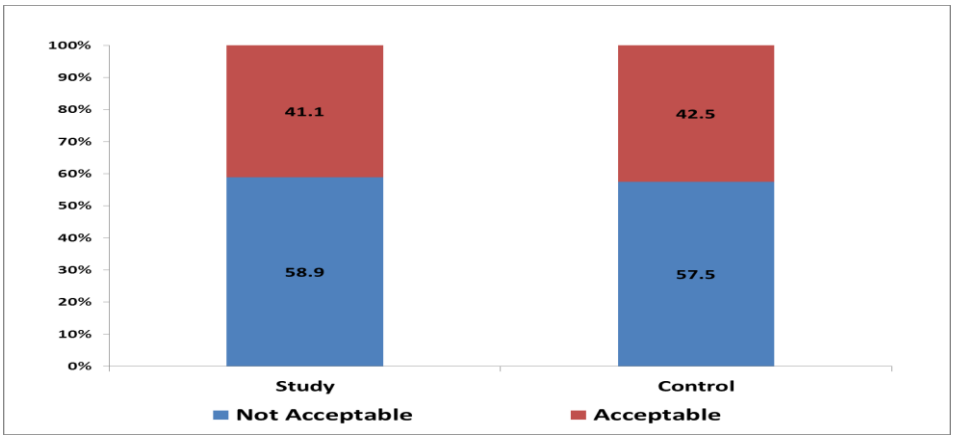
Peak Expiratory flow rate[16] (PEFR) was assessed with the help of flowmeter in all school children in study and control area. The percentage deviation of the recorded PEFR from expected PEFR was analysed with respect to study and control area.

Following tables present PEFR results amongst school children from study and control areas.

Table 13: comparison of PEFR

Parameter	Category	Statistics	Area		Total
			Study	Control	
PEFR % deviation	<=70%	Count	590	573	1163
		%	58.9%	57.5%	58.2%
	> 70%	Count	411	424	835
		%	41.1%	42.5%	41.8%
Total		Count	1001	997	1998
		%	100.0%	100.0%	100.0%

Figure 7 : PEFR % deviation in study and control area



About 58.9 % students from study area had not acceptable PEFR%, whereas 57.5% students from control area had not acceptable PEFR%. There is no significant difference observed in PEFR% result between Study and Control group (p-value by Chi-square= 0.130). This implies the lung function of children in these two areas is comparable.

[16]Chowgule, Shetye, Parmar. Lung Function Tests In Normal Indian Children. Indian Pediatrics.Volume 32. February 1995.

Following tables present PEFR results amongst school children from study area.

Table 14: Illness episode with respect to PEFR

Parameter	Category	Statistics	PEFR % deviation		Total
			Not acceptable (<=70)	Acceptable (> 70)	
Illness episode	Never	Count	102	57	159
		%	17.3%	13.9%	15.9%
	2-4 times	Count	424	311	735
		%	71.9%	75.9%	73.5%
	More than 4	Count	64	42	106
		%	10.8%	10.2%	10.6%
Total		Count	590	410	1000
		%	100.0%	100.0%	100.0%

More than 80% students from study area having not acceptable PEFR% had more illness episodes.

Chapter 5: Finding of adults epidemiological data

To observe the effects of air pollution in different age groups, adults (more than 18 years) were also included in the study. As the study focused on effects of ambient air pollution on health, those working in any of the industries were not included in the study.

Clinical manifestations

Following tables present age and sex wise distribution of sample from study and control areas.

Table 15: mean age of sample in study and control area

Area	Mean	Standard Deviation
Study	40.88	12.859
Control	39.71	10.693

The mean age of respondents in study and control group was almost similar. Hence, the sample was comparable for the effects of air pollution.

Table 16: age wise distribution of sample

Age group	Statistics	Area	
		Study	Control
<=45 years	Count	927	706
	%	69.2%	70.4%
> 45 years	Count	412	297
	%	30.8%	29.6%
Total	Count	1339	1003
	%	100.0%	100.0%

The age of respondents was categorized into two groups, less than or equal to 45 years and more than 45 years, considering that the productivity is more in the age less than 45 years and decreases with increase in age. Distribution of sampe in study and control area was similar for both the age groups.

Table 17: Sex wise distribution of the sample

Sex	Statistics	Area	
		study	control
Male	Count	652	510
	%	48.4%	50.6%
Female	Count	693	498
	%	51.6%	49.4%
Total	Count	1347	1008
	%	100.0%	100.0%

Table 18: Mean BMI with respect to study and control area

Area	Study(n=1271)	Control(n=984)
Mean	21.52	20.38
Std. Deviation	3.91	3.78

The table above shows that the mean BMI of the populations in study and control area are almost similar. Hence, the clinical parameters of these two groups can be compared.

Table 19: Number of illness episodes with respect to area

Parameter	Category	Statistics	Area		Total
			study	control	
Number of Illness Episodes	never	Count	213	218	431
		%	15.9%	21.7%	18.4%
	2-4 times	Count	891	574	1465
		%	66.7%	57.2%	62.6%
	more than 4 times	Count	232	212	444
		%	17.4%	21.1%	19.0%
Total		Count	1336	1004	2340
		%	100.0%	100.0%	100.0%

Higher % of adults in study area (84.1%) had illness episodes (2-4 times or more than 4 times) compared to control area (78.3%).

Table 20: Respiratory symptoms

Symptom/ disease	Area					Distance between home and industry within Study Group				
	Study		Control		Statistical Test result (p-value)	<5km		>5km		Statistical Test result (p-value)
	n=1335		n=1004			n=1070		n=265		
	Number	Percentage	Number	Percentage		Number	Percentage	Number	Percentage	
Respiratory System										
Dry Cough	259	19.4	103	10.3	0.000 Significant	208	19.4	51	19.2	0.943 Not Sig
Productive Cough	81	6.1	30	3	0.001 Significant	68	6.4	13	4.9	0.376 Not Sig
Night Cough	111	8.3	61	6.1	0.041 Significant	87	8.1	24	9.1	0.622 Not Sig
Continuous Sneezing	195	14.6	68	6.8	0.000 Significant	185	17.3	10	3.8	0.000 Sig
Sore Throat	188	14.1	54	5.4	0.000 Significant	178	16.6	10	3.8	0.000 Sig
Wheeze	107	8	15	1.5	0.000 Significant	104	9.7	3	1.1	0.000 Sig
Chest Pain	214	16	133	13.3	0.060 Not Significant	173	16.2	41	15.5	0.777 Not Sig
Breathlessness	185	13.9	47	4.7	0.000 Significant	171	16	14	5.3	0.000 Sig
COPD	13	1	9	0.9	0.811 Not Significant	12	1.1	1	0.4	0.264 Not Sig
Asthma	105	7.9	42	4.2	0.000 Significant	95	8.9	10	3.8	0.006 Sig
Tuberculosis	6	0.5	1	0.1	0.126 Not Significant	5	0.5	1	0.4	0.842 Not Sig
LRTI - Pneumonia	7	0.5	0	0	-	7	0.7	0	0	

Figure 8A: Respiratory symptoms with respect to area

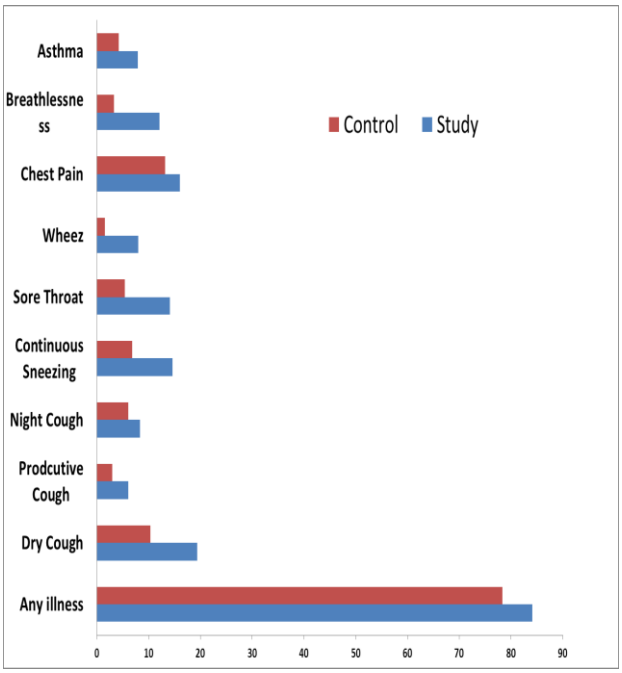
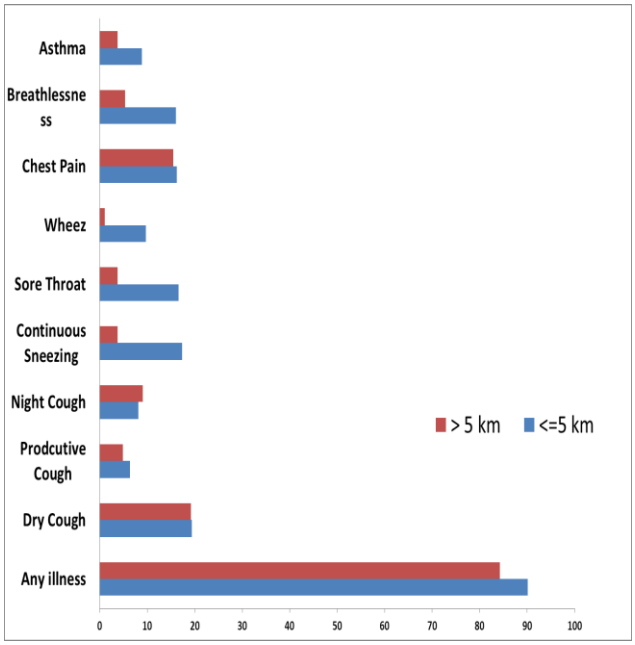


Figure 7B: Respiratory prevalence in study area with respect to distance



Higher % of adults in study area (19.4%) reported dry cough compared to control area (10.3%). Higher % of adults in study area (6.1%) reported productive cough compared to control area (3.0%). Higher % of adults in study area (8.3%) reported night cough compared to control area (6.1%).

Higher % of adults in study area (14.6%) reported sneezing compared to control area (6.8%). Higher % of adults in study area (14.1%) reported sore throat compared to control area (5.4%). Higher % of adults in study area (8.0%) reported wheeze compared to control area (1.5%). Higher % of adults in study area (16.0%) reported chest pain/ tightness compared to control area (13.2%). Both sites had stray cases of tuberculosis. Higher % of adults in study area (12.1%) reported breathlessness compared to control area (3.3%). Study area reported 7 cases of LRTI. Control area reported none. Higher % of adults in study area (7.9%) reported asthma compared to control area (4.2%). Small % of respondents both, in study and control areas reported COPD. Higher % of adults in study area (2.6%) reported IHD compared to control area (0.3%). Higher % of adults in study area (10.9%) reported hypertension compared to control area (6.0%). Higher % of adults in study area (12.9%) had skin problems compared to control area (8.3%). Higher % of adults in study area (14.1%) reported ocular infections compared to control area (8.1%). Similar % of respondents who stayed less than 5 km or more than 5 km from industry reported presence of dry cough.

Higher % (6.4%) of adults in study area who stayed less than 5 kms from industry reported productive cough as compared to adults (4.9%) who stayed at a distance of more than 5 km from industry. Almost similar % of respondents who stayed less than 5 km or more than 5 km from industry reported presence of night cough. Higher % (17.3%) of adults in study area who stayed less than 5 kms from industry reported continuous sneezing as compared to adults (3.8%) who stayed at a distance of more than 5 km from industry. Higher % (16.6%) of adults in study area who stayed less

than 5 kms from industry reported sore throat as compared to adults (3.8%) who stayed at a distance of more than 5 km from industry. Higher % (9.7%) of adults in study area who stayed less than 5 kms from industry reported productive cough as compared to adults (1.1%) who stayed at a distance of more than 5 km from industry. Almost similar % of respondents who stayed less than 5 km or more than 5 km from industry reported presence of night cough. Higher % (16.0%) of adults in study area who stayed less than 5 kms from industry reported breathlessness as compared to adults (5.3%) who stayed at a distance of more than 5 km from industry. Higher % (8.4%) of adults in study area who stayed less than 5 kms from industry reported asthma as compared to adults (2.7%) who stayed at a distance of more than 5 km from industry. COPD was negligible in both areas.

Statistically significant difference is observed in prevalence of following symptoms between study and control groups:

- ✓ Dry Cough: 19.4% in Study and 10.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Sneezing: 14.6% in Study and 6.8% in Control, p=0.000 Significant by Chi Square test
- ✓ Sore throat: 14.1 in Study and 5.4% in Control, p=0.000 Significant by Chi Square test
- ✓ Breathlessness: 13.9 in Study and 4.7% in Control, p=0.000 Significant by Chi Square test
- ✓ Asthma: 7.9 in Study and 4.2% in Control, p=0.000 Significant by Chi Square test

Statistically significant difference is observed in prevalence of following symptoms between <= 5 km and > 5km distance

- ✓ Sore Throat: 16.6% in <=5 km and 3.8% in > 5 km, p=0.000 Significant by Chi Square test
- ✓ Sneezing: 17.3% in <=5 km and 3.8% in > 5 km, p=0.000 Significant by Chi Square test
- ✓ Wheeze: 9.7% in <=5 km and 1.1% in > 5 km, p=0.000 Significant by Chi Square test
- ✓ Breathlessness: 16.0% in <=5 km and 5.3% in > 5 km, p=0.000 Significant by Chi Square test

Presence of any respiratory symptom was also assessed with respect to age and sex of the respondents.

Table 21: Presence of respiratory symptom with respect to age group

Age groups	Statistics	Study	Control
<=45 years	Count	390	188
	%	65.2%	64.4%
> 45 years	Count	208	104
	%	34.8%	35.6%
Total	Count	598	292
	%	100.0%	100.0%

The percentage of people having any respiratory symptom or disease was significantly higher (p-value by Chi-square=0.004) in less than or equal to 45 years age group in both study as well as control area, which shows that the respiratory symptom or disease was associated with air pollution and not because of old age.

Table 22: Presence of respiratory symptom with respect to sex

Sex	Statistics	Study	Control
Male	Count	284	144
	%	47.3%	49.1%
Female	Count	316	149
	%	52.7%	50.9%
Total	Count	600	293
	%	100.0%	100.0%

Presence of respiratory symptom was more in females as compared to males in both study and control area. The difference was not significant (p-value by Chi-square=0.337).

Table 23: Cardiovascular symptoms

	Area					Distance between home and industry within Study Group				
Symptom/ disease	Study		Control		Statistical Test result (p-value)	<5km		>5km		Statistical Test result (p-value)
	n=1335		n=1004			n=1070		n=265		
	Number	Percentage	Number	Percentage		Number	Percentage	Number	Percentage	
IHD	35	2.6	3	0.3	0.000 Significant	32	3	3	1.1	0.087 Not Significant
Hypertension	145	10.9	60	6	0.000 Significant	131	12.3	14	5.3	0.001 Significant

Figure 9: Cardiovascular symptoms with respect to area

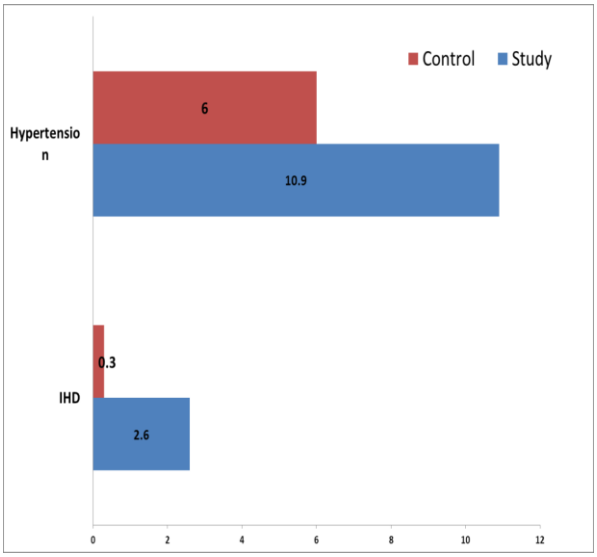
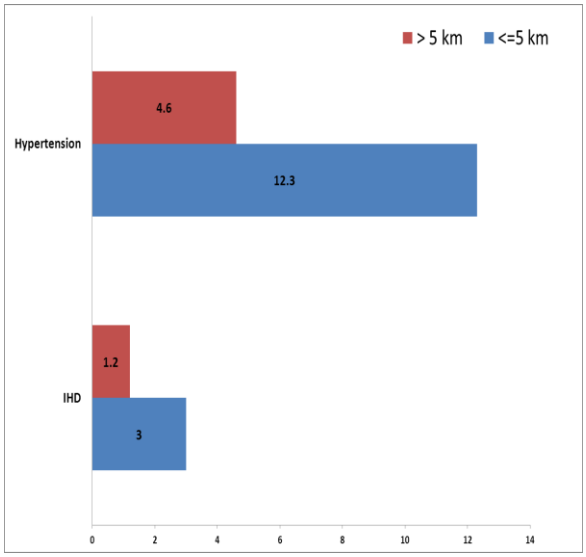


Figure 10: Cardiovascular symptoms with respect to distance



Higher % (3.0%) of adults in study area who stayed less than 5 kms from industry reported IHD as compared to adults (1.1%) who stayed at a distance of more than 5 km from industry. Higher % (12.3%) of adults in study area who stayed less than 5 kms from industry reported hypertension as compared to adults (5.3%) who stayed at a distance of more than 5 km from industry.

Table 24: Dermatological symptoms

	Area					Distance between home and industry within Study Group				
Symptom/ disease	Study		Control		Statistical Test result (p-value)	<5km		>5km		Statistical Test result (p-value)
	n=1335		n=1004			n=1070		n=265		
	Number	Percentage	Number	Percentage		Number	Percentage	Number	Percentage	
Dermatology										
Skin Infection	86	6.5	31	3.1	0.000 Significant	74	7	12	4.5	0.149 Not Significant
Redness Rash	58	4.4	9	0.9	0.000 Significant	55	5.2	3	1.1	0.004 Significant
Skin Itch / Eczema	107	8.1	46	4.6	0.001 Significant	102	9.6	5	1.9	0.000 Significant
Ulcers	30	2.3	7	0.7	0.003 Significant	27	2.5	3	1.1	0.169 Not significant

Figure 11: Dermatological symptoms with respect to area

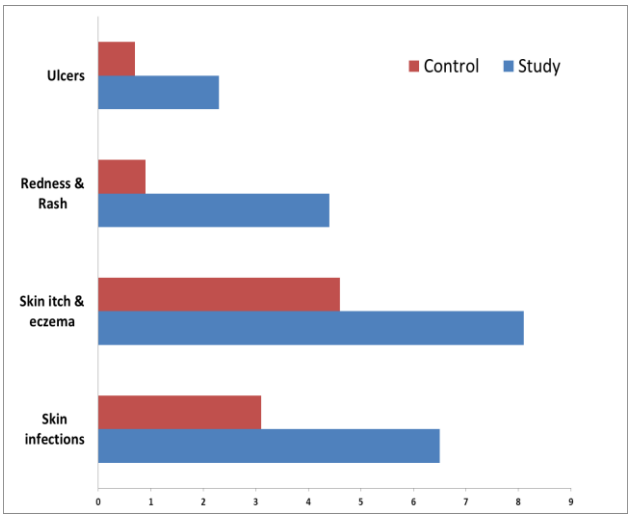
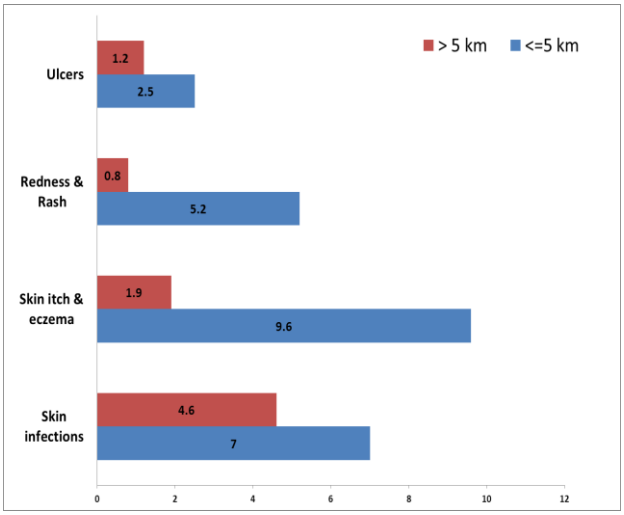


Figure 12: Dermatological symptoms with respect to distance of house from industry



Higher percentage of all dermatological symptoms was seen in study area as compared to control area.Those who stayed within less than 5km from industry had more percentage of dermatological symptoms than those who stayed more than 5km from industry.

Table 25: Ophthalmic symptoms

	Area					Distance between home and industry within Study Group				
Symptom/ disease	Study		Control		Statistical Test result (p-value)	<5km		>5km		Statistical Test result (p-value)
	n=1335		n=1004			n=1070		n=265		
	Number	Percentage	Number	Percentage		Number	Percentage	Number	Percentage	
Ophthalmolgy										
Ocular infections	187	14.1	81	8.1	0.000 Significant	179	16.9	8	3	0.000 Significant
Eye Irriatation	356	26.8	154	15.4	0.000 Significant	332	31.3	24	9.1	0.000 Significant

Figure 13: Ophthalmic symptoms with respect to area

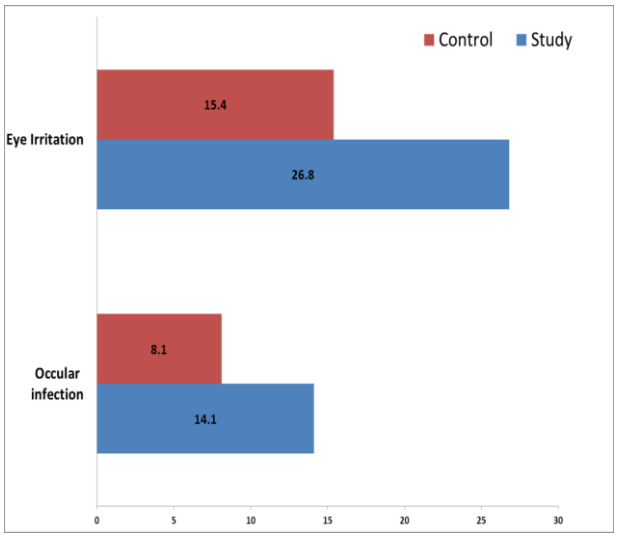
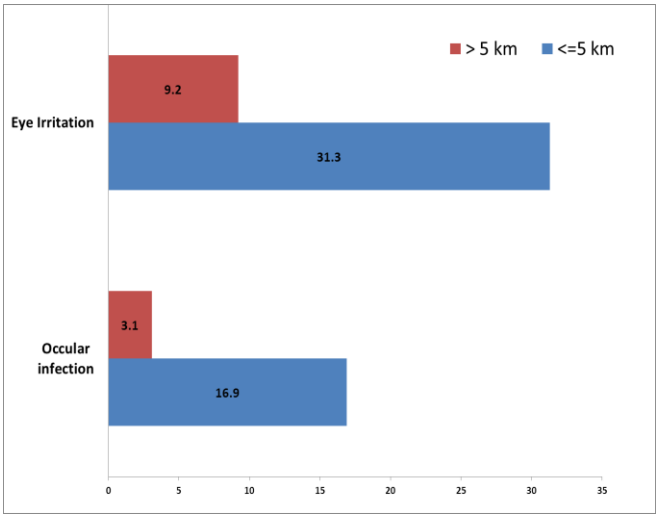


Figure 14: Ophthalmic symptoms with respect to distance of house from industry



Higher percentage of ocular infections and eye irritation was seen in study area as compared to control area. Percentage of ophthalmic symptoms was significantly higher in the respondents within 5km from industry as compared to the respondents more than 5km from industry.

The association of symptoms was also assessed with respect to presence of industry in / near the village, in order to observe the effect of different industries on the health. Following table represents the association of these symptoms with industry present in / or near the village.

Table 26: Village wise prevalence of respiratory symptoms in study area

Name of theTown	Type of industry	Statistics	Symptoms							
			Dry Cough	Productive Cough	Night Cough	Sneezing/ nasal irritation	Sore Throat	Wheeze	Breathlessness	Asthma
Ballarpur	Coal, Paper	Count	10	4	7	20	25	8	28	2
		%	16.9%	6.8%	11.9%	33.9%	42.4%	13.6%	47.5%	3.4%
Bamani	Coal, Paper	Count	3	4	0	1	0	0	1	4
		%	3.0%	4.0%	.0%	1.0%	.0%	.0%	1.0%	4.0%
Durgapur	Coal, Steel, Thermal	Count	53	21	22	89	70	51	59	31
		%	24.2%	9.6%	10.0%	40.6%	31.8%	23.2%	26.9%	14.2%
Gadchandur	Cement	Count	27	9	21	21	19	10	22	16
		%	22.5%	7.5%	17.5%	17.5%	15.8%	8.3%	18.5%	13.6%
Kothari	Coal	Count	12	8	10	1	2	1	1	2
		%	15.0%	10.0%	12.5%	1.3%	2.5%	1.3%	1.3%	2.5%
Pandharkawda	Coal	Count	6	2	0	2	1	3	3	4
		%	5.5%	1.8%	.0%	1.8%	.9%	2.7%	2.7%	3.6%
Rajura	Coal, Cement	Count	25	1	14	6	8	0	5	7
		%	16.3%	0.7%	9.2%	3.9%	5.2%	.0%	3.3%	4.6%
Sakharwahi	Coal, Cement	Count	46	13	16	29	34	28	32	14
		%	30.5%	8.6%	10.6%	19.3%	22.5%	18.5%	21.2%	9.3%
Tadali	Coal, thermal	Count	56	10	10	14	15	3	19	14
		%	36.1%	6.5%	6.5%	9.0%	9.7%	1.9%	12.3%	9.0%
Usegaon	Coal	Count	10	4	2	4	5	0	0	3
		%	9.3%	3.7%	1.9%	3.8%	4.7%	.0%	.0%	2.8%
Visapur	Coal, Paper	Count	11	5	9	8	9	3	15	8
		%	13.8%	6.3%	11.3%	10.0%	11.3%	3.8%	18.8%	10.0%

Above table shows that the presence of respiratory symptoms is higher in the villages with multiple industries as compared to villages with single industry. Also, the presence of cement and thermal industry showed higher percentage of respiratory symptoms than other industries.

The association of respiratory symptoms was assessed with respect to six MPCB monitoring sites. As the levels of pollutants were lower at Chandrapur SRO and Chandrapur MIDC sites, the villages under these two sites were grouped together in one group and the remaining villages into other group.

Following table shows the association of respiratory symptoms at these six sites.

Table 27: Sitewise distribution of respiratory symptoms

Symptom	Statistics	MPCB monitoring site	
		Chandrapur SRO+ Chandrapur MIDC	other MPCB sites
Dry Cough	Count	65	194
	%	21.7%	18.7%
ProductiveCough	Count	29	52
	%	9.7%	5.0%
NightCough	Count	32	79
	%	10.7%	7.6%
Continuous Sneezing / nasalirritation	Count	90	105
	%	30.1%	10.2%
SoreThroat	Count	72	116
	%	24.0%	11.2%
Wheeze	Count	52	55
	%	17.3%	5.3%
Breathlessness	Count	60	125
	%	20.1%	12.1%
Asthma	Count	33	72
	%	11.0%	7.0%
COPD	Count	4	9
	%	1.3%	0.9%

Prevalence of respiratory symptoms as reported is seen higher at Chandrapur SRO and MIDC monitoring sites as compared to other MPCB monitoring sites.

The pollutants monitored are below the standard value in Chandrapur (SRO & MIDC), despite more number of industries but the prevalence of respiratory symptoms is more in that area. So, the pollutants affecting could be other such as $PM_{2.5}$ or CO/CO_2 which is not monitored. Therefore, those pollutants' levels are not available.

Chapter 6: Diagnostic findings in adults

A. Spirometry

Obstructive lung disease[17]occurs because of damage to the lungs or narrowing of the airways inside the lungs. Due to this, exhaled air comes out more slowly than normal. At the end of a full exhalation, an abnormally high amount of air may still linger in the lungs.

Common conditions in obstructive lung disease are-

- ✓ Chronic obstructive pulmonary disease (COPD), which includes emphysema and chronic bronchitis
- ✓ Asthma
- ✓ Bronchiectasis
- ✓ Cystic fibrosis

Pulmonary function test (PFT) is an important means for the estimation of pulmonary function, which can be comparable to the ECG for heart. Pulmonary function test is also used to monitor the status of patients with chronic obstructive lung diseases. In clinical practice, spirometry is helpful for the overall assessment of pulmonary function and is associated with the PFT.[18,19] Spirometry is a physiological test that measures how an individual inhales or exhales volumes of air as a function of time. The basic measure in spirometry may be volume or flow.

Forced Vital Capacity (FVC) is the maximum volume of air exhaled with utmost forced effort from a highest inspiration, i.e. vital capacity performed with a maximally forced expiratory effort, expressed in litres at body temperature and ambient pressure saturated with water vapour.

Forced Expiratory Volume in 1 second (FEV1) is the maximum volume of air exhaled in the first second of a forced expiration from a position of full inspiration, expressed in litres at body temperature and ambient pressure saturated with water vapour.[20]

[17]http://www.webmd.com/lung/obstructive-and-restrictive-lung-disease, assessed on 12/02/2014, 6.38PM

[18]Vijayasekaran D, Subramanyam L, Balachandran A, Shivbalan S. Spirometry in clinical practice. Indian Pediatr.2003;40:626–32.

[19]Mallik SK, Jindal SK. Pulmonary function tests in healthy children. Indian Pediatr. 1985;22:677–81.

[20]Miller et.al.Standardisation of spirometry.EurRespir J 2005; 26: 319–338.

The FEV1 is reduced in both obstructive and restrictive lung disease. The FEV1 is reduced in obstructive lung disease because of increased airway resistance. It is reduced in restrictive lung disease because of the low vital capacity.

FEV1/FVC is the ratio of the vital capacity which is expired in the first second of maximal expiration. In patients with obstructive lung disease, FEV1/FVC decreases. Restrictive disorders have a near normal FEV1/FVC.

In obstructive lung disorders, the forced expiratory volume in 1 second (FEV1) is usually decreased, the forced vital capacity (FVC) is usually normal and the ratio FEV1/FVC is decreased.[21]

Following formulae were used for predicted values of FEV1 and FVC.

Table 28: Formulae for predicted values of pulmonary function tests[22]

Parameter	Sex	Formula	Standard error of estimate
FVC	Male	$-3.44 - 0.013A - 0.00005A^2 + 0.048H$	0.497
	Female	$-2.05 - 0.014A - 0.00004A^2 + 0.035H$	0.447
FEV1	Male	$-1.90 - 0.025A + 0.00006A^2 + 0.036H$	0.417
	Female	$-1.07 - 0.030A + 0.00013A^2 + 0.027H$	0.323

A= age in years, H= height in cm

Following values were taken for categorization of FEV1[23]

FEV1/FVC % deviation- Normal>= 80 %
Abnormal <80%

[21]David P. Johns and Rob Pierce. SPIROMETRY: The Measurement and Interpretation of Ventilatory Function in Clinical Practice. Commissioned by the Thoracic Society of Australia and New Zealand.McGraw Hill.3rd edition. March 2008.
[22]Aggarwal AN, Gupta D and Jindal SK. Interpreting Spirometric Data Impact of Substitution of Arm Span for Standing Height in Adults From North India. CHEST / 115 / 2 / February, 1999. Pg. 557-62.Downloaded From: http://xn--chestjournal-obb6343ijob.chestpubs.org/ on 11/30/2013.
[23]Swanney et al. Using the lower limit of normal for the FEV1/FVC ratio reduces the misclassification of airway obstruction. Thorax 2008;63:1046–1051.

Following tables present diagnostic findings amongst adults from study and control areas as well as with respect to distance of home from industry within study area.

Table 29: Pulmonary function tests with respect to area and distance

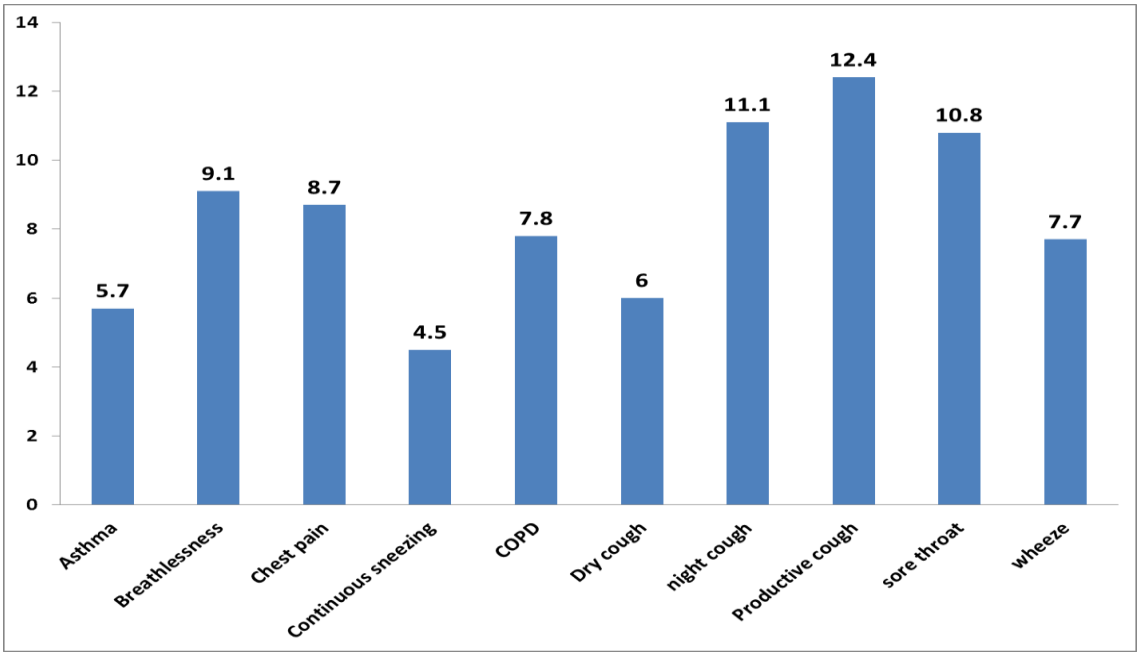
	Area					Distance between home and industry within Study Group				
Symptom/ disease	Study		Control		Statistical Test result (p-value)	<5 km		> 5km		Statistical Test result (p-value)
	n=720		n=490			n=583		n=136		
	Number	Percentage	Number	Percentage		Number	Percentage	Number	Percentage	
Abnormal FEV1/FVC % deviation	49	6.8	19	3.9	0.030 Significant	32	5.5	17	12.5	-

Significant difference is seen between abnormal FEV1/FVC % in study and control area.

Table 30: FEV1/FVC % deviation with respect to respiratory symptoms

Symptom/disease	Statistics	FEV1/FVC % deviation		p-value
		Abnormal	Normal	
Dry cough	Count	11	182	0.892
	%	5.70%	94.30%	
Productive cough	Count	5	50	0.231
	%	9.09%	90.91%	
Night cough	Count	8	84	0.160
	%	8.70%	91.30%	
Continuous sneezing	Count	6	127	0.625
	%	4.51%	95.49%	
Sore throat	Count	10	118	0.205
	%	7.81%	92.19%	
Wheeze	Count	4	63	0.862
	%	5.97%	94.03%	
Chest pain	Count	19	152	0.001
	%	11.11%	88.89%	
Breathlessness	Count	14	99	0.001
	%	12.39%	87.61%	
Asthma	Count	9	74	0.027
	%	10.84%	89.16%	
COPD	Count	1	12	0.716
	%	7.69%	92.31%	

Figure 15: percentage deviation of FEV1/FVC % with respect to presence of symptoms



Percentage of abnormal FEV1/FVC% deviation was significantly higher in chest pain, breathlessness and asthma.

FEV1/FVC% deviation with respect to MPCB monitoring sites was also analysed. Following table shows the association of FEV1/FVC% deviation and MPCB monitoring sites.

Table 31: FEV1/FVC% deviation and MPCB monitoring sites

Parameter	Category	Statistics	MPCB site	
			Chandrapur SRO+MIDC	other MIDC sites
FEV1/FVC % deviation	normal	Count	150	521
		%	96.2%	92.4%
	mild	Count	6	33
		%	3.8%	5.9%
	moderate	Count	0	4
		%	.0%	.7%
	severe	Count	0	6
		%	.0%	1.1%

Percentage of abnormal FEV1/FVC % deviation was higher at other MPCB sites (7.7%) as compared to Chandrapur SRO and MIDC (3.8%).

B. ECG findings

ECGs were performed on ten percent sample. Following parameters were used for reporting of the ECGs-

1. P wave- present / absent, amplitude-2.5mm, peak-tall, notched, biphasic, breadth
2. PR interval- 0.20 s
3. QRS complex- presence of pathological Q wave, presence of R', progression of R wave in V1-V6, time- 0.1 s, prolongation
4. ST segment- elevation, depression
5. T wave- depression, flat
6. Axis-QRS complex positive in lead I and II Both -normal

Following parameters were studies for reading the ECGs-

Table 32: ECG differences and interpretation[24]

Deflection	Abnormality
P wave	Taller- >2.5 mm- Right atrial hypertrophy Wider and notched- Left atrial hypertrophy
Q wave	Old Myocardial Infarction (considered significant only if more than .04 m sec or more than 1/4th of R wave
QRS complex	Prolonged- >0.10 Sec- Ventricular arrhythmia
R wave Progression- R wave becomes taller and the S wave becomes smaller as electrical activity moves across the heartfrom right to left- V1 to V6	left ventricular hypertrophy, COPD, left bundle branch block, or anteroseptal MI
ST segment	Elevation->1mm in limb leads and >2mm in chest limb- Evolving acute MI Early repolarization (normal variant in young adults) Pericarditis Ventricular aneurysm Pulmonary embolism Intracranial hemorrhage Depression- Myocardial ischemia Left ventricular hypertrophy Intraventricular conduction defects Medication (e.g., digitalis) Reciprocal changes in leads opposite the area of acute injury
U wave	Abnormal increase in U-wave amplitude is most commonly due to drugs or hypokalemia. Prominent U waves- increased susceptibility to the torsades de pointe type of ventricular tachycardia Inversion of the U wave in the precordial leads- subtle sign of ischemia.
Axis Normally, the QRS axis ranges from –30° to +100° An axis more negative than –30° is referred to as left axis deviation, while an axis more positive than +100° is referred to as right axis deviation.	Left axis deviation- associated with left ventricular hypertrophy, a block in the anterior fascicle of the left bundle system (left anterior fascicular block or hemiblock), or inferior myocardial infarction. Right axis deviation- may also occur as a normal variant (particularly in children and young adults); as a spurious finding due to reversal of the left and right arm electrodes; or in conditions such as right ventricular overload (acute or chronic), infarction of the lateral wall of the left ventricle, dextrocardia, left pneumothorax, or left posterior fascicular block. Lead I positive, Lead II positive: Normal Axis Lead I positive, Lead II negative: Left axis deviation. Lead I negative, Lead II positive: Right axis deviation

[24]Fauci, Braunwald, Kasper. Harrison's Principles of Internal Medicine. The McGraw-Hill Companies, Inc. 17th Edition, 2008.

ECG results were divided in two categories- normal and abnormal. Abnormal ECG findings included following findings-

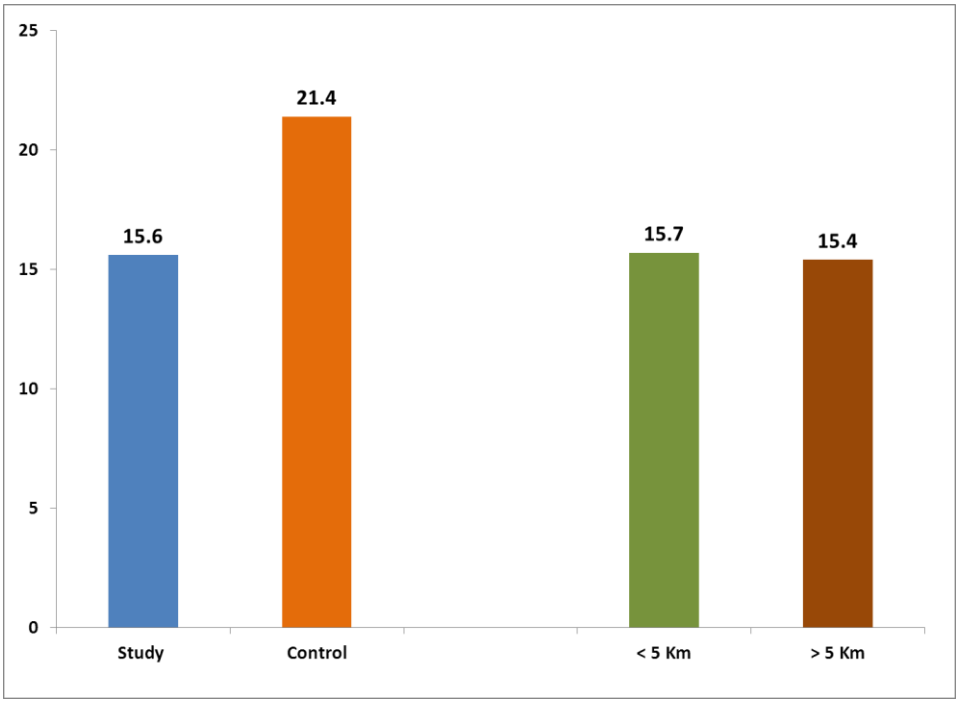
1. Atrial Fibrillation
2. Early repolarization
3. Incomplete RBBB
4. Inferolateral ischemia
5. Lateral wall ischemia
6. LBBB
7. Left axis deviation
8. LV hypertrophy
9. Old MI
10. Sinus bradycardia
11. Sinus tachycardia
12. Small Q in inferolateral leads

Association of these results with area, distance of house from industry and cardiac symptoms was tested. Following tables present abnormal ECG findings from study and control areas and with respect to distance of home from industry within study area.

Table 33: Abnormal ECG findings with respect to area

Parameter	Statistics	area		p-value	Distance of home from industry		
		Study n= 147	Control n=98		<5km n=121	>5k n=26	p-value
ECG findings	Count	23	21	0.248	19	4	0.968
	%	15.6%	21.4%		15.7%	15.4%	

Figure 16: Abnormal ECG findings



No significant difference was observed between the percentage of abnormal ECGs in study and control areas. (p-value=0.248).

Abnormal ECG findings in study area were also analysed to observe association with chest pain.

Table 34: ECG findings in study area with respect to chest pain

Symptom	Statistics	ECG findings	
		Normal	Abnormal
Chest Pain	Count	21	1
	%	16.9%	4.3%

Percentage of chest pain was higher (16.9%) in the normal ECG findings as compared to abnormal ECG findings (4.3%). The association between these findings was statistically not significant (p-value by Chi-square test- 0.120).

C. Blood tests

Blood tests were carried out with the purpose of assessing effect of air pollution on health with the help of haematological and biochemical blood markers.

Various studies have shown association between high levels of both gaseous and particulate air pollutants and increased morbidity and mortality due to respiratory and cardiovascular diseases. The exact mechanism though unknown, probable reason for this can be consistent inflammation and hemostasis caused by these pollutants. Continued exposure to these pollutants may lead to synthesis of inflammatory biomarkers such as C-reactive protein and also can have impact on normal liver and kidney physiology.[25] Studies have also confirmed that chronic exposure to SO2 may lead to chromosome aberrations (CA), sister chromatid exchanges (SCE) and micronuclei (MN) in peripheral blood lymphocytes and bone marrow depression.(Nemmar et al. 2004; Radomski et al. 2005; Seaton et al. 1995).

[25]Rudez et al. Effects of Ambient Air Pollution on Hemostasis and Inflammation. Environmental Health Perspectives .volume 117- number 6. June 2009. Pg.No.995-96.

The normal values of these markers are presented below-

Hematology-

Table 35: normal blood values of hematological blood markers[26, 27]

Red Blood Cells (RBCs)	4.8 million/_L in females; 5.4 million/_L in males
White Blood Cells	4000–11,000/L
Neutrophils	60–70% of all WBCs
Eosinophils	2–4% of all WBCs
Basophils	0.5–1% of all WBCs
Lymphocytes-	20–25% of all WBCs
Monocytes-	3–8% of all WBCs 12–20 _m diameter
Platelets (Thrombocytes)-	150,000–400,000/_L
Hematocrit (HCT; packed cell volume)	38-54% (men) 36-47% (women)
Hemoglobin (Hb)	12-16 g/dL
Mean corpuscular volume (MCV) -	80-94 µm3
Mean corpuscular hemoglobin (MCH)	27-32 pg
Mean corpuscular hemoglobin concentration	33.4-35.5 g/dL

Biochemistry-

Table 36: normal blood values of biochemical blood markers[28, 29]

Glucose	80-120 mg/dL
Triglycerides	40-200 mg/dL
Cholesterol	<225 mg/dL
High Density Lipoprotein(HDL)	40-60 mg/dl
Low Density Lipoprotein(LDL)	70-130mg/dl
Bilirubin(total)	<1.0 mg/dL total
Urea	20-40 mg/dL
Creatinine	1.0-2.0 mg/dL
C reactive protein	0.2-3mg/L

[26]Fauci, Braunwald, Kasper. Harrison's Principles of Internal Medicine. The McGraw-Hill Companies, Inc. 17th Edition, 2008.
[27]Food and Drug Administration (FDA).Investigations Operations Manual 2013.Appendix C. Pg. No. 428-29.
[28]Food and Drug Administration (FDA).Investigations Operations Manual 2013.Appendix C. Pg. No. 428-29.
[29]Fauci, Braunwald, Kasper. Harrison's Principles of Internal Medicine. The McGraw-Hill Companies, Inc. 17th Edition, 2008.

Following tables present findings of blood investigation conducted in adults of study and control areas.

Table 37: Mean and standard deviation of hematological tests in study and control area

Parameter	Study (n=1325)		Control (n= 951)	
	mean	SD	mean	SD
WBC	6700/µl	4.5	6600/ µl	2.4
RBC	5.0 x 106/ µl	4.6	4.8 x 106/ µl	2.7
HGB	12.1 gm/dl	2.4	11.9 gm/dl	2.8
MCH	27.4%	13.7	26.4 %	7.4
PLT	2.56 x 105/ µl	77.2	2.68 x 105/ µl	79.6

Mean values of haematological tests in study and control area were seen more or less similar.

Table 38: Percentage of abnormal hematological investigations

Parameter	Statistics	Area		p-value
		Study	Control	
WBC count	Count	99	112	-
	%	7.3%	11.1%	
RBC count	Count	1102	826	-
	%	81.7%	82.0%	
Hemoglobin percentage	Count	656	521	-
	%	48.6%	51.7%	
Platelet count	Count	119	153	-
	%	8.8%	15.2%	

No significant difference was found in the percentage of abnormal hematological investigations between study and control area.

Table 39: mean values of biochemistry tests with respect to area

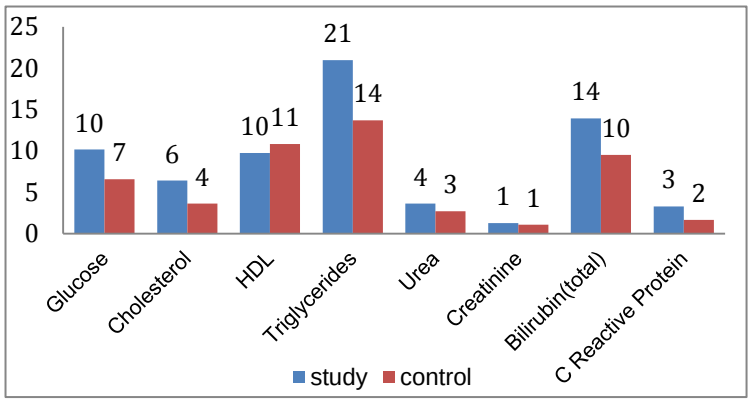
Parameter	Study (n=1112)		Control (n=738)	
	mean	SD	mean	SD
BIT/Total Bilirubin	1.9 mg/dl	11.7	1.1 mg/dl	6.6
Cholesterol	158.0 mg/dl	43.2	133.0 mg/dl	45.5
Creatinine	1.7 mg/dl	7.8	1.7 mg/dl	7.6
Glucose	80.4 mg/dl	57.0	84.4 mg/dl	33.8
High Density Lipoprotein	45.7 mg/dl	14.0	46.5 mg/dl	17.3
Low Density Lipoprotein	100.9 mg/dl	287.5	86.3 mg/dl	26.1
Triglyceride	148.0 mg/dl	97.9	130.4 mg/dl	90.2
Urea	24.7 mg/dl	13.6	21.3 mg/dl	8.6
C-Reactive Protein	1.5 mg/l	7.1	0.6 mg/l	1.8

All the biochemistry tests are within normal limits in both study as well as control area. Mean values of cholesterol, low density lipoprotein and triglycerides are higher in study area as compared to control area, showing increased risk of cardiovascular diseases in study area. Mean value of C reactive protein is almost double in study area in comparison with control area. This indicates that there are more inflammatory conditions in study area as compared to control area, which could be attributed to chronic exposure to air pollutants.

Table 40: Percentage of abnormal biochemistry tests with respect to area

Parameter	Statistics	Area		p-value
		Study(n=1112)	Control(n=738)	
Glucose	Count	65	31	0.035
	%	10.17%	6.57%	
Cholesterol	Count	71	26	0.010
	%	6.40%	3.63%	
HDL	Count	107	79	0.452
	%	9.74%	10.82%	
LDL	Count	0	0	-
	%	0.00%	0.00%	
Triglycerides	Count	232	96	0.000
	%	20.96%	13.71%	
Urea	Count	40	20	0.283
	%	3.62%	2.71%	
Creatinine	Count	14	8	0.735
	%	1.26%	1.09%	
Bilirubin(total)	Count	155	70	0.004
	%	13.94%	9.50%	
C Reactive Protein	Count	36	12	0.036
	%	3.29%	1.67%	

Figure 17: abnormal biochemistry tests with respect to area



Percentage of abnormal blood glucose level was higher in study area (10.17%) as compared to control area (6.57%). Higher percentage of abnormal blood cholesterol was observed in study area (6.40%) as compared to control area (3.63%). Higher percentage of abnormal serum triglycerides was seen in study area (20.96%) as

compared to control area (13.71%). More percentage of abnormal blood urea was observed in study area (3.62%) as compared to control area (2.71%). Percentage of abnormal serum creatinine levels was almost similar in study and control area. Higher percentage of abnormal total bilirubin was observed in study area (13.94%) as compared to control area (9.50%). Percentage of abnormal C reactive protein was higher in study area (3.29%) as compared to control area (1.67%). All the blood samples collected have normal LDL values in study as well as control area.

Statistically significant difference was observed in the following parameters, in study and control area-

- ✓ Glucose- 10.17% in study area and 6.57% in control area, p-value by Chi square=0.035
- ✓ Cholesterol- 6.40% in study area and 3.63% in control area, p-value by Chi square=0.010
- ✓ Triglycerides- 20.96%in study area and 13.71% in control area, p-value by Chi square=0.000
- ✓ Bilirubin- 13.94% in study area and 9.50% in control area, p-value by Chi square=0.004
- ✓ C reactive protein- 3.29% in study area and 1.67% in control area, p-value by Chi square=0.036

Chapter 7: Findings of data from private practitioners

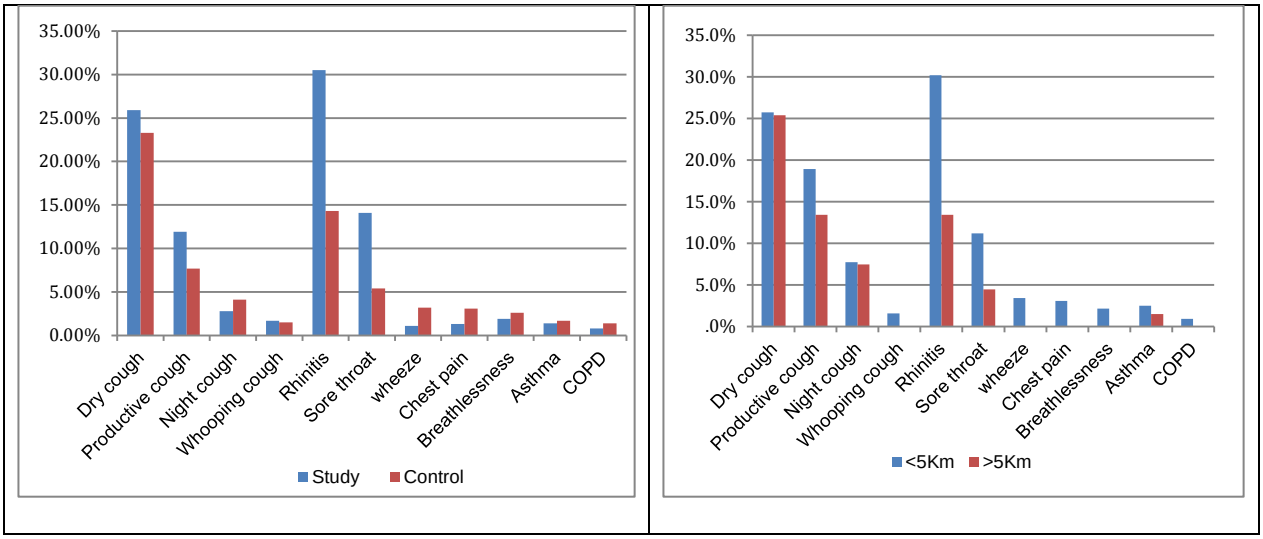
Progressive data of patients attending private clinics was recorded with the help of practitioners from the study as well as control area. Out of twenty practitioners opted for the study, four practitioners did not participate, out of which two were from study area and two from control area.

Following tables present findings of progressive data from practitioners.

Table 41: Respiratory symptoms

Symptom	Statistics	Area			Distance between home and industry within Study Group		
		study	control	Statistical Test result (p-value)	<5km	>5km	Statistical Test result (p-value)
Dry cough	Count	165	417	0.19 Not significant	226	17	.951
	%	25.90%	23.30%		25.7%	25.4%	
Productive cough	Count	76	138	0.001 Significant	166	9	0.266
	%	11.90%	7.70%		18.9%	13.4%	
Night cough	Count	18	73	0.152 Not significant	68	5	.934
	%	2.80%	4.10%		7.7%	7.5%	
Rhinitis	Count	194	255	0.000 Significant	265	9	.004
	%	30.50%	14.30%		30.2%	13.4%	
Sore throat	Count	90	96	0.000 Significant	98	3	.222
	%	14.10%	5.40%		11.2%	4.5%	
Wheeze	Count	7	57	0.005 Significant	30	0	.124
	%	1.10%	3.20%		3.4%	.0%	
Chest pain	Count	8	55	-	27	0	.145
	%	1.30%	3.10%		3.1%	.0%	
Breathlessness	Count	12	47	0.295	19	0	.224
	%	1.90%	2.60%		2.2%	.0%	
Asthma	Count	9	30	0.648	22	1	.604
	%	1.40%	1.70%		2.5%	1.5%	
COPD	Count	5	25	0.229	8	0	.433
	%	0.80%	1.40%		.9%	.0%	

Figure 18: Respiratory symptoms



Number of patients visiting private practitioners is comparatively less than in the control area. This could be because of the fact that, in study area, majority of them could be accessing the industry run health facilities.

This statement is supported by the number of cases coming in a period of 1 month to practitioners in these areas.

Table 42: Cardiovascular symptoms

Symptom	Statistics	Area			Distance between home and industry within Study Group		
		study	control	Statistical Test result (p-value)	<5km	>5km	Statistical Test result (p-value)
IHD	Count	2	24	0.03	6	2	0.048
	%	0.30%	1.30%		0.7%	3.0%	
Hypertension	Count	13	116	-	19	1	0.709
	%	2.00%	6.50%		2.2%	1.5%	

Figure 19: Cardiovascular symptoms

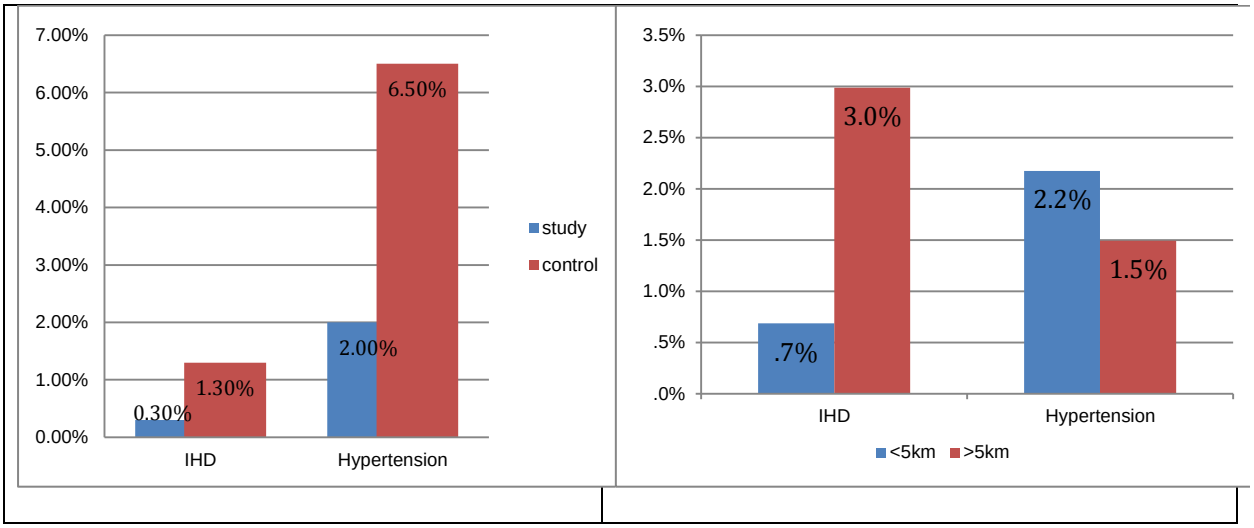


Table 43: Dermatological symptoms

Symptom / Disease	Response	Statistics	Area			Distance between home and industry within Study Group		
			study	control	Statistical Test result (p-value)	<5km	>5km	Statistical Test result (p-value)
Ulcer	yes	Count	5	39	-	18	4	.038
		%	0.90 %	2.20 %		2.1 %	6.1 %	
Redness / rash	yes	Count	13	43	-	20	4	.066
		%	2.40 %	2.40 %		2.3 %	6.0 %	
Atopic dermatitis	yes	Count	12	23	0.63	16	1	.838
		%	2.20 %	1.30 %		1.8 %	1.5 %	
Skin infection	yes	Count	18	30	-	32	1	.358
		%	1.7	3.3		3.7 %	1.5 %	

Figure 20: Dermatological symptoms

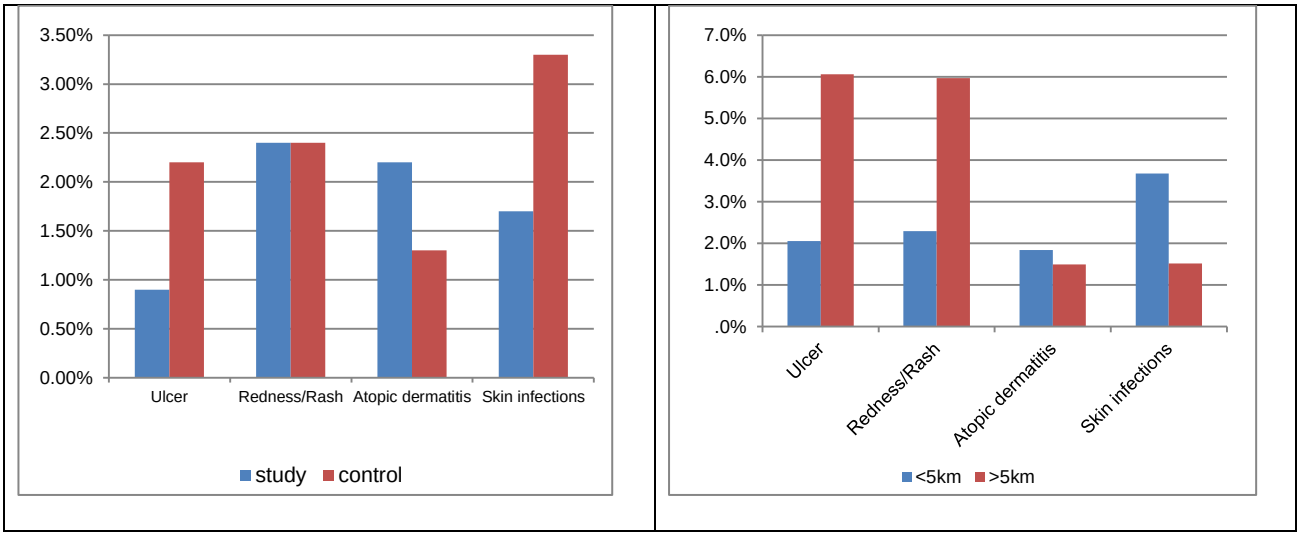
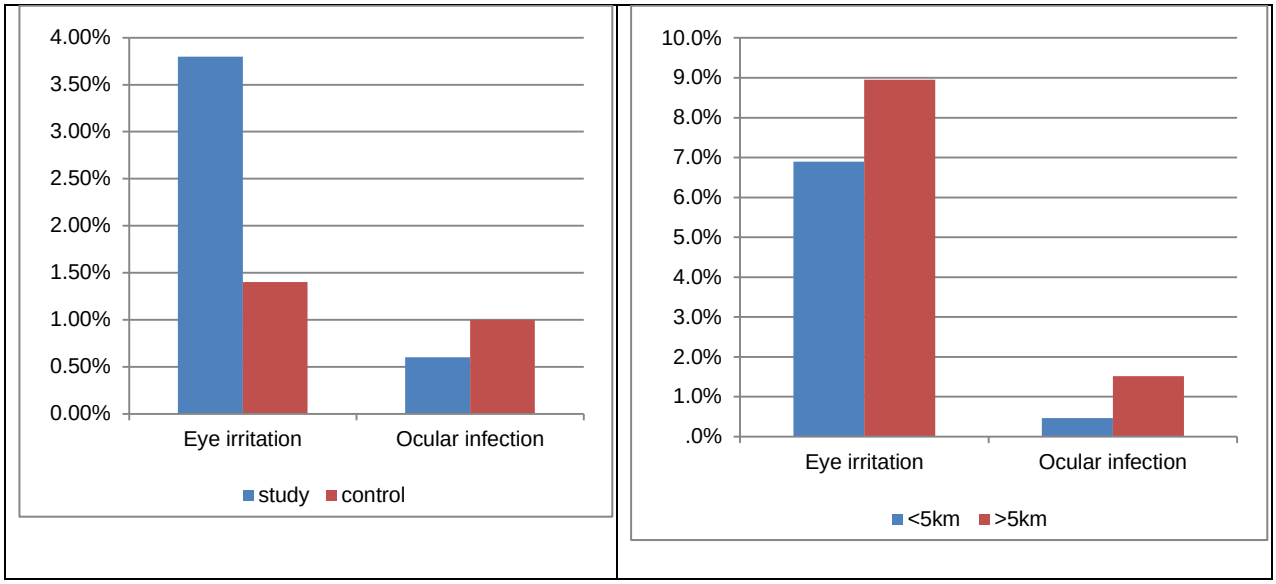


Table 44: Ophthalmic symptoms

Symptom / Disease	Response	Statistics	Area			Distance between home and industry within Study Group		
			study	control	Statistical Test result (p-value)	<5km	>5km	Statistical Test result (p-value)
Eye irritation	yes	Count	20	24		60	6	.526
		%	3.80 %	1.40 %	0	6.9 %	9.0 %	
Ocular infection	Yes	Count	3	17	-	4	1	.260
		%	0.60 %	1.00 %		.5%	1.5 %	

Figure 21: Ocular infections



Statistically significant difference is observed in prevalence of following respiratory symptoms between study and control groups:

- ✓ Productive Cough: 11.9% in Study and 7.7% in Control, p=0.001 Significant by Chi Square test
- ✓ Rhinitis: 30.5% in Study and 14.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Sore throat: 14.1% in Study and 5.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Breathlessness: 15.5% in Study and 2.1% in Control, p=0.000 Significant by Chi Square test
- ✓ Eye irritation: 3.8% in study and 1.4% in control, p=0.000 Significant by Chi Square test

Within study group, following symptoms showed statistically significant difference for distance less than 5Km and more than 5Km between home and industry.

- ✓ Rhinitis: 30.2% in less than 5Km and 13.4% in more than 5Km, p=0.004 Significant by Chi Square test

Chapter 8: Critical comparison of Chandrapur with Nagpur and India

Prevalence of respiratory symptoms which were reported in the study was compared with the prevalence of these symptoms at national level and in Nagpur. The Indian study on epidemiology of Asthma, Respiratory symptoms and Chronic bronchitis (INSEARCH) was used as reference for this prevalence. The methodologies used for current study and INSEARCH study are discussed in following table.

Table 45: Methodology of compared prevalence studies[30]

Current study	INSEARCH study
Study design- Mixed, both qualitative and quantitative Data collection included- 1. structured questionnaire aimed at demographic details and presence of respiratory symptoms and diseases, 2. Lung function tests in school children and adults, 3. Blood biomarkers 4. ECGs of subset of adult sample. Symptoms were recorded as per reported by respondent.	Study design- Quantitative, multicentric study at twelve sites across India Data was collected with the help of structured questionnaire aimed at demographic details and presence of respiratory symptoms and diseases. The symptoms were recorded as per reported by respondent.

[30] Jindal SK. Indian study on epidemiology of Asthma, Respiratory symptoms and Chronic bronchitis (INSEARCH). September 2010

Following tables present critical comparisons of various parameters of current study with respect to values of these parameters at National level and also neighbouring district (Nagpur).

Table 46: Comparison of Chandrapur Study Results with Nagpur

Symptom	Prevalence in Chandrapur study area	Prevalence in Nagpur	p-value and significance	Odds ratio with 95% Confidence interval	Interpretation
Wheeze	8	1.6	0.000, significant	5.40 (4.24-6.88)	Risk of having wheeze is 5.4 times higher in study area than in Nagpur
Breathlessness	12.1	1.7	0.000, significant	7.87 (6.37-9.71)	Risk of having breathlessness is 7.87 times higher in study area than in Nagpur
Night cough	8.3	1.7	0.000, significant	5.18(4.09-6.56)	Risk of having night cough is 5.18 times higher in study area than in Nagpur
Asthma	7.9	1.7	0.000, significant	4.84(3.81-6.15)	Risk of having asthma is 4.84 times higher in study area than in Nagpur
Any of the respiratory symptom ***	44.6	4.1	0.000, significant	19.21(16.77-22.01)	Risk of having any respiratory symptom is 19.21 times higher in study area than in Nagpur

***** Dry Cough, Productive Cough, Night Cough, Cont Sneezing nasal irritation, Sore Throat, Wheeze, Chest Pain tightness, Breathlessness**

Table 47: Comparison of Chandrapur Study Results with India

Symptom	Prevalence in Chandrapur study area	Prevalence in India	p-value	Odds ratio with 95% Confidence interval	Interpretation
Wheeze	8	2.6	0.000, significant	3.17 (2.59-3.89)	Risk of having wheeze is 3.17 times higher in study area than in India
Breathlessness	12.1	2.9	0.000, significant	4.51 (3.8-5.34)	Risk of having breathlessness is 4.51 times higher in study area than in India
Night cough	8.3	4.6	0.000, significant	1.84 (1.51-2.25)	Risk of having night cough is 1.84 times higher in study area than in India
Asthma	7.9	2.3	0.000, significant	3.53 (2.87-4.34)	Risk of having asthma is 3.53 times higher in study area than in India
Any of the respiratory symptom ***	44.6	8.6	0.000, significant	8.60 (7.71-9.61)	Risk of having any respiratory symptom is 8.60 times higher in study area than in India

***** Dry Cough, Productive Cough, Night Cough, Cont Sneezing nasal irritation, Sore Throat, Wheeze, Chest Pain tightness, Breathlessness**

Table 48: Comparison of Chandrapur Control Area Results with Nagpur

Symptom	Prevalence in Chandrapur Control area	Prevalence in Nagpur	p-value and significance	Odds ratio with 95% Confidence interval	Interpretation
Wheeze	1.5	1.6	0.84, not significant	0.95 (0.54 – 1.64)	No significant difference between control area and Nagpur prevalence
Breathlessness	3.3	1.7	0.000, significant	1.97 (1.34 – 2.88)	Risk of having breathlessness is 1.97 times higher in Control area than in Nagpur
Night cough	6.1	1.7	0.000, significant	3.73 (2.77 – 5.01)	Risk of having night cough is 3.73 times higher in Control area than in Nagpur
Asthma	4.2	1.7	0.000, significant	2.5 (1.77 – 3.52)	Risk of having asthma is 2.5 times higher in Control area than in Nagpur
Any of the respiratory symptom ***	29.0	4.1	0.000, significant	9.64 (8.20 – 11.32)	Risk of having any respiratory symptom is 9.64 times higher in Control area than in Nagpur

***** Dry Cough, Productive Cough, Night Cough, Cont Sneezing nasal irritation, Sore Throat, Wheeze, Chest Pain tightness, Breathlessness**

Table 49: Comparison of Chandrapur Control Area Results with India

Symptom	Prevalence in Chandrapur Control area	Prevalence in India	p-value	Odds ratio with 95% Confidence interval	Interpretation
Wheeze	1.5	2.6	0.02, significant	0.56 (0.32 – 0.95)	Risk is not significantly higher
Breathlessness	3.3	2.9	0.050, not significant	1.13 (0.78 – 1.61)	No significant difference
Night cough	6.1	4.6	0.030, significant	1.32 (1.01-1.73)	Risk is not significantly higher
Asthma	4.2	2.3	0.000, significant	1.82 (1.32 – 2.51)	Risk of having asthma is 1.82 times higher in Control area than in India
Any of the respiratory symptom ***	29.0	8.6	0.000, significant	4.36 (3.79 – 5.01)	Risk of having any respiratory symptom is 4.36 times higher in Control area than in India

***** Dry Cough, Productive Cough, Night Cough, Cont Sneezing nasal irritation, Sore Throat, Wheeze, Chest Pain tightness, Breathlessness**

Table 50: Comparison of Chandrapur district with Ngpur

Symptom	Prevalence in Chandrapur district	Prevalence in Nagpur	p-value and significance	Odds ratio with 95% Confidence interval	Interpretation
Wheeze	5.2	1.6	0.000, significant	3.42 (2.72-4.30)	Risk of having wheeze is 3.42 times higher in Chandrapur district than in Nagpur
Breathlessness	8.2	1.7	0.000, significant	5.21 (4.28-6.33)	Risk of having wheeze is 5.21 times higher in Chandrapur district than in Nagpur
Night cough	7.3	1.7	0.000, significant	4.55 (3.72-5.57)	Risk of having wheeze is 4.55 times higher in Chandrapur district than in Nagpur
Asthma	6.2	1.7	0.000, significant	3.82 (3.09-4.72)	Risk of having wheeze is 3.82 times higher in Chandrapur district than in Nagpur
Any of the respiratory symptom ***	37.9	4.1	0.000, significant	14.43 (12.84-16.23)	Risk of having wheeze is 14.43 times higher in Chandrapur district than in Nagpur

***** Dry Cough, Productive Cough, Night Cough, Cont Sneezing nasal irritation, Sore Throat, Wheeze, Chest Pain tightness, Breathlessness**

Table 51: Comparison of Chandrapur district with India

Symptom	Prevalence in Chandrapur district	Prevalence in India	p-value	Odds ratio with 95% Confidence interval	Interpretation
Wheeze	5.2	2.6	0.000, significant	2.01 (1.66-2.43)	Risk of having wheeze is 2.01 times higher in Chandrapur district than in Nagpur
Breathlessness	8.2	2.9	0.000, significant	2.98 (2.56-3.48)	Risk of having wheeze is 2.98 times higher in Chandrapur district than in Nagpur
Night cough	7.3	4.6	0.000, significant	1.62 (1.38-1.90)	Risk of having wheeze is 1.62 times higher in Chandrapur district than in Nagpur
Asthma	6.2	2.3	0.000, significant	2.78 (2.34-3.31)	Risk of having wheeze is 2.78 times higher in Chandrapur district than in Nagpur
Any of the respiratory symptom ***	37.9	8.6	0.000, significant	6.53 (5.99-7.11)	Risk of having wheeze is 6.53 times higher in Chandrapur district than in Nagpur

***** Dry Cough, Productive Cough, Night Cough, Cont Sneezing nasal irritation, Sore Throat, Wheeze, Chest Pain tightness, Breathlessness**

This comparison shows that the risk of getting respiratory symptoms and diseases like asthma is much higher in Chandrapur district than in any other place in India including Nagpur district, which is close to Chandrapur.

Chapter 9:Gist of Qualitative data

Five qualitative interviews were conducted, which included Member of Legislative Assembly, Regional Officer of Pollution Control Board,Chandrapur, District Health Officer, Representative of local newspaper and a NGO member. Important findings from these interviews are listed below-

12.1 Member of Legislative assembly

During discussion, he shared different LAQs raised by him in Assembly. He further narrated & commented about the pollution in Chandrapur as it is a District in India where air & water pollution is highest. Central pollution board evaluated environment in December 2009 of 88 industrial areas and at that time Chandrapur recorded highest i.e. 83.88 units which has ranked Chandrapur as second in India for pollution. If any pocket shows more than 70 units, then it is said to be high risk area. Hence, action plan was prepared which included 11 action points to be undertaken to reduce the pollution. He further told that pollution in Chandrapur is because of –

Air pollution because of Industrial release of gases in the air.

Water pollution because water used in the industries is released in river & water stream without any treatment.

Solid waste is created by industries which is not disposed of sanitarily.

Because of large number of vehicles coming for industries, lot of gases are released.

There are number of rules & regulations by Government to avoid contamination & pollution like -

- ✓ Section 25 of the Water (prevention & control of water) Act 1974
- ✓ Section 24 of Air (prevention & control of pollution) Act 1981
- ✓ Authorization under Rule 5 of Hazardous Wastes (management & handling) Rules 1989 & amendment Rules 2003.

However, pollution control board doesn't observe these rules & regulations rigidly and they just take nominal action like Japti of Bank hami.

In the year 2001–12, water samples of 3510 villages were examined which revealed excess of nitrates & fluoride in water because of which various diseases occur.

Similarly, he mentioned that because of air pollution people suffer from diseases like asthma, TB, bronchitis, pulmonary diseases, diseases related to heart, eyes & skin.

About 4000 vehicles (trucks) are involved in the industrial business per day because of which the dust is disbursed and about 6-8 inches dust we can see on the road and glasses of vehicle. Because of these trucks, carbon monoxide & sulphur gases are released and consequently people suffer from different health problems.

Because of the power plants, about 150,000 tones of coal per annum is burnt & we can imagine how it will increase the pollution which will cause health problems.

The following suggestions have been recommended by him to overcome the problem:

1. As the life of the vehicle is predetermined and the old one are replaced in metro cities likewise, old machineries and equipments in industries too should be replaced over a period of time.

2. The waste water from industries (effluents) should not be released into water bodies unless its it treated appropriately and this needs to be regulated and monitored stringently.

3. The use of electric sub meters at filtration plants should be made compulsory and based on the number of units of electricity consumed will determine the regular use of effluent plant.

4. Bypass road for Chandrapur to be built urgently.

5. Corporate Social Responsibility – Responsibility of industries to set aside a part of their profit towards environmental protection, which should be to the tune of 15%.

12.2 District Health Officer

The causes of air pollution is not only the mines and industries, but also the transport of the products like coal, cement, etc. in uncovered trucks. The bad conditions of the road further worsens the situation leading to rise in air pollution.

There is a health hazard in the form of various clinical ailments due to ambient air pollution in the district. There are large number of patients with respiratory symptoms attending in almost all hospitals. However, the patients who are working in mining and other industries do not come to government health institutes. Many of them seek treatnment at their respective industry hospitals. Therefore, its difficult to estimate the actual number of patients. From the forest areas or where there are no industries, these illnesses are comparatively less.

Asthma and bronchitis cases are frequent. COPD patients are also more. From PHCs they are referred to General hospital if they are of serious nature. The incidence of lung cancer cases is not much.

NCD cases are also high. Many patients with hypertension, IHD, Diabetes Mellitus come to PHCs and rural hospitals. There is a reporting system for NCDs since the inception of program.

There is a need to create awareness among people for taking preventive action to avoid the effects of pollution. They can make use of masks, if possible, mouth and nose can be covered with wet cloth (rumal) which will absorb the dust and will not let it enter the body.

12.3 Representative of local newspaper

He told that Chandrapur district is one of the most polluted district in India according to Pollution Control Board. He tried to collect the information about how the study is going to be conducted. He commented that instead of taking the data and examining the children it will be better if the data is collected from medical store / chemists about the drugs used for treatment of respiratory & cardiac diseases which occur because of the pollution.

According to him, coal industry is the most responsible industry in this regard.

12.4 Regional Officer of Pollution Control Board

There are three districts under the region – Chandrapur, Gadchiroli & Yavatmal. Central Pollution Control Board has declared Ghughus, Tadali, Ballarpur and MIDC Chandrapur as seriously contaminated polluted areas in Dec. 2009. Suspendable Particulate Matter (SPM) and RSPM (Respiratory Suspendable Particulate Matter) are measured from ambient air at 6 stations which are there for monitoring purpose. Similarly, SO2 and Nitrous Oxide are also monitored.

It was also noted that there is no proper mechanism in place to monitor levels of PM2.5, CO and CO2 gases at Pollution Control Monitoring Centres..

SPM is released not only from industries but also from vehicles & kitchens where people use coal as fuel. Pollution Control Board has adopted short term as well as long term measures for control the air pollution. Short term measures include upgradation or replacement of the pollution control system e.g. old plants of ACC was closed at Ghughus. Long term plan includes the measures suggested to Government especially in the Corporation area for solid waste disposals & sewage treatment plants, bypass road at Chandrapur, ban of heavy vehicles on city's arterial roads, etc. The Officers of Pollution Control Board should pay surprise & random visits to different industries. There is no alarming increase of SO2 & Nitrous Oxide in ambient air.

Holistic approach is required to be considered for reduction of air pollution. eg. besides industry measures, the other measures like ban on use of coal as a fuel in kitchen, reduction in vehicular emissions etc.

12.5 Representative from NGO

A representative from NGO Sarvoday Yuva Vikas which is working since 1998 have been interviewed. According to him, the growth of industries is essential for increasing the economy of the district. Because of industrialization, the general public has to bear industrial health and other hazards to some extent. However, he has blamed mainly thermal power plants that contribute towards air pollution. He suggested a remedy to increase the height of chimneys of the power plants. He further remarked that it is mainly labourers who suffer from ill health and these labourers are migrants from neighboring states like Chhatisgarh & Andhra Pradesh. Local laborers constitute only 5%. He further suggested to check the health of these migrant (floating) labourers.

Conclusion:

- ✓ From all the qualitative interviews, it was stated that the source of air pollution is not only from industries, but also from the transport associated with these industries and domestic use of coal used as kitchen fuel.
- ✓ Levels of suspended particulate pollutants are considerably high, which is of public health concern, as it is associated with increased respiratory, skin and ophthalmic diseases, increased admissions and morbidities.

- ✓ Need of proper monitoring and strict action against sources of the air pollutants was reiterated.

- ✓ Intersectoral convergence for reduction of air pollution and its effects on health was also suggested.

- ✓ Short term measures suggested like upgradation or replacement of the old pollution control system (machinery & equipments)

- ✓ Long term plan measures suggested to Government especially in the Corporation areas for proper solid waste disposals & setting up of sewage treatment plants, construction of bypass road at Chandrapur, ban on plying of heavy vehicles on city's arterial roads, etc.

- ✓ Establishment of monitoring of levels of PM2.5, CO and CO2 gases at Pollution Control Monitoring Centres.

Chapter 10:Conclusion and discussion

Discussion-

MPCB data analysis: The data for last three (2010-2013) years was downloaded from 6 monitoring stations of MPCB - Chandrapur SRO, Chandrapur MIDC, Ballarshah, Tadali MIDC, Ghuggus & Rajura.

Monthly averages were calculated and they were compared with the respective standard value for each of the pollutant.

- ✓ For all three years, emission of SO2 and NOx remained below standard[31] values. In the year 2010-11, the levels of emission were higher at all six monitoring sites as compared to later years. The emissions of both these gases are seen reduced in 2012-13, probably due to intervention measures taken by MPCB.
- ✓ Concentration of RSPM and SPM remained within standard limit at Chandrapur city and MIDC area, whereas at remaining four sites concentration of these particles is persistently higher than standard value.
- ✓ There is a downward trend in values which could be attributed to monsoons when the pollutant particles settle down quickly.
- ✓ Chandrapur Pollution Control Board Regional Officer has pointed out similar facts and also added that apart from industries, vehicular emmision and household coal run chulhas contribute particularly more to RSPM and SPM.

Children's Data:

Clinical Manifestations: Wheeze, productive cough and breathlessness are the indicative symptoms for asthma and COPD. Hence, these symptoms were also asked along with other respiratory symptoms such as dry cough, productive cough etc.

Close to 30% of children had dry cough in study area, the percentage of which in control area was 21.3% Equal proportion (7.8%) of children in study and control area experienced productive cough in last 1 year. More than 22% of children in study area had night cough in last 1 year, as compared to 13.6 % children in control area. More children in study area (17.8%) experienced continuos sneezing as compared to the children in control area (10.2%). More children in study area (6.8%) had sore throat as compared to the children in control area (3.3%). More children in study area (6.1%) had presence of wheeze as compared to the children in control area (4.4%). More children in study area (6.7%) had chest pain as compared to the children in control area (3.3%). More children in study area (3.2%) experienced breathlessness as compared to the children in control area (1.7%). More children in study area (2%) had asthma as compared to the children in control area (1.2%). Barring a couple of cases in control areas, tuberculosis was not evident. Pneumonia was very low. Only one student in study area had pneumonia in last 1 year.

[31] Standard values are taken as per MPCB daily monitoring records of air quality.

More than 30% of students residing less than 5 kms from the industry experienced dry cough as compared to students staying at a distance of more than 5 kms from an industry (19.5%). Amongst the students who experienced productive cough higher percentage (8.7%) were staying at less than 5 kms distance from nearest industry. More number of students were staying at less than 5 kms distance from nearest industry experienced night cough (23.6%) as compared to those students staying at a distance of more than 5 kms from industry (15.1%). Amongst the students who had continuos sneezing, more (19.7%) were staying at less than 5 kms distance from nearest industry. Amongst the students who experienced wheeze, maximum (6.8%) were staying at less than 5 kms distance from nearest industry. Amongst the students who had chest pain, higher proportion (7.5%) of these students were staying at less than 5 kms distance from nearest industry. Amongst the students who experienced sore throat, maximum (7.5%) were staying at less than 5 kms distance from nearest industry. All the students who experienced breatlessness were staying at less than 5 kms distance from nearest industry. Amongst the students who had asthma, maximum were staying at less than 5 kms distance from nearest industry.

Statistically significant difference is observed in prevalence of following symptoms between study and control groups:

- ✓ Dry Cough: 29.5% in Study and 21.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Night Cough: 22.3% in Study and 13.6% in Control, p=0.000 Significant by Chi Square test
- ✓ Sneezing: 17.8% in Study and 10.2% in Control, p=0.000 Significant by Chi Square test

Statistically significant difference is observed in prevalence of following symptoms between <= 5 km and > 5km distance

- ✓ Dry Cough: 31.4% in <=5 km and 19.5% in > 5 km, p=0.003 Significant by Chi Square test
- ✓ Night Cough: 23.6% in <=5 km and 15.1% in > 5 km, p=0.018 Significant by Chi Square test
- ✓ Sneezing: 19.1% in <=5 km and 10.7% in > 5 km, p=0.011 Significant by Chi Square test

There is no significant difference observed in PEFR% result between Study and Control group (p-value by Chi-square= 0.130). This implies that the lung function of children in these two areas is comparable.
However, more than 80% students from study area having not acceptable PEFR% had more illness episodes. Chi-square test for this was not significant.

The prevalence of respiratory symptoms is higher in villages with multiple industries as compared to the villages with single industry. However, in case of village having cement industry, the prevalence is higher irrespective of number of industries present in or near the village.

Adult Data:

To observe the effects of air pollution in different age groups, adults (more than 18 years) were also included in the study. As the study focused on effects of ambient air pollution on health, those working in any of the industries were not included in the study.

Higher % of adults in study area (84.1%) had illness episodes (2-4 times or more than 4 times) compared to control area (78.3%). Higher % of adults in study area (19.4%) reported dry cough compared to control area (10.3%). Higher % of adults in study area (6.1%) reported productive cough compared to control area (3.0%). Higher % of adults in study area (8.3%) reported night cough compared to control area (6.1%). Higher % of adults in study area (14.6%) reported sneezing compared to control area (6.8%). Higher % of adults in study area (14.1%) reported sore throat compared to control area (5.4%). Higher % of adults in study area (8.0%) reported wheeze compared to control area (1.5%). Higher % of adults in study area (16.0%) reported chest pain / tightness compared to control area (13.2%). Higher % of adults in study area (12.1%) reported breathlessness compared to control area (3.3%). Study area reported 7 cases of LRTI. Control area reported none. Higher % of adults in study area (7.9%) reported asthma compared to control area (4.2%). Small % of respondents both, in study and control areas reported COPD. Higher % of adults in study area (2.6%) reported IHD compared to control area (0.3%). Higher % of adults in study area (10.9%) reported hypertension compared to control area (6.0%). Higher % of adults in study area (12.9%) had skin problems compared to control area (8.3%). Higher % of adults in study area (14.1%) reported ocular infections compared to control area (8.1%).

Similar % of respondents who stayed less than 5 kms or more than 5 kms from industry reported presence of dry cough. Higher % (6.4%) of adults in study area who stayed less than 5 kms from industry reported productive cough as compared to adults (4.9%) who stayed at a distance of more than 5 kms from industry. Almost similar % of respondents who stayed less than 5 kms or more than 5 kms from industry reported presence of night cough. Higher % (17.3%) of adults in study area who stayed less than 5 kms from industry reported continuous sneezing as compared to adults (3.8%) who stayed at a distance of more than 5 kms from industry. Higher % (16.6%) of adults in study area who stayed less than 5 kms from industry reported sore throat as compared to adults (3.8%) who stayed at a distance of more than 5 kms from industry. Higher % (9.7%) of adults in study area who stayed less than 5 kms from industry reported wheeze as compared to adults (1.1%) who stayed at a distance of more than 5 kms from industry. Higher % (16.0%) of adults in study area who stayed less than 5 kms from industry reported breathlessness as compared to adults (5.3%) who stayed at a distance of more than 5 kms from industry. Higher % (8.9%) of adults in study area who stayed less than 5 kms from industry reported asthma as compared to adults (3.8%) who stayed at a distance of more than 5 kms from industry. COPD was negligible in both areas. Higher % (3.0%) of adults in study area who stayed less than 5 kms from industry reported IHD as compared to adults (1.1%) who stayed at a distance of more than 5 kms from industry. Higher % (12.3%) of adults in study area who stayed less than 5 kms from industry reported hypertension as compared to adults (5.3%) who stayed at a distance of more than 5 kms from industry. Higher percentage

of all dermatological symptoms was seen in study area as compared to control area. Those who stayed within less than 5 kms from industry had higher percentage of dermatological symptoms than those who stayed more than 5 kms from industry. Higher percentage of ocular infections and eye irritation was seen in study area as compared to control area.

Statistically significant difference is observed in prevalence of following symptoms between study and control groups:

- ✓ Dry Cough: 19.4% in Study and 10.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Sneezing: 14.6% in Study and 6.8% in Control, p=0.000 Significant by Chi Square test
- ✓ Sore throat: 14.1% in Study and 5.4% in Control, p=0.000 Significant by Chi Square test
- ✓ Breathlessness: 13.9 in Study and 4.7% in Control, p=0.000 Significant by Chi Square test
- ✓ Asthma: 7.9% in Study and 4.2% in Control, p=0.000 Significant by Chi Square test
- ✓ Ischemic heart disease: 2.6% in Study and 0.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Hypertension: 10.6% in Study and 6% in Control, p=0.000 Significant by Chi Square test
- ✓ Skin infections: 6.5% in Study and 3.1% in Control, p=0.000 Significant by Chi Square test
- ✓ Redness/rash: 4.4% in Study and 0.9% in Control, p=0.000 Significant by Chi Square test
- ✓ Skin itch/eczema: 8.1% in Study and 4.6% in Control, p=0.001 Significant by Chi Square test
- ✓ Ulcers: 2.3% in Study and 0.7% in Control, p=0.003 Significant by Chi Square test
- ✓ Ocular infections: 14.1% in Study and 8.1% in Control, p=0.000 Significant by Chi Square test
- ✓ Eye irritation: 26.8% in Study and 15.4% in Control, p=0.000 Significant by Chi Square test

Statistically significant difference is observed in prevalence of following symptoms between <= 5 kms and > 5 kms distance

- ✓ Sore Throat: 16.6% in <=5 kms and 3.8% in > 5 kms, p=0.000 Significant by Chi Square test
- ✓ Sneezing: 17.3% in <=5 kms and 3.8% in > 5 kms, p=0.000 Significant by Chi Square test
- ✓ Wheeze: 9.7% in <=5 kms and 1.1% in > 5 kms, p=0.000 Significant by Chi Square test
- ✓ Breathlessness: 16.0% in <=5 kms and 5.3% in > 5 kms, p=0.000 Significant by Chi Square test
- ✓ Hypertension: 12.3% in <=5 kms and 5.3% in > 5 kms, p=0.001 Significant by Chi Square test
- ✓ Redness/rash: 5.2% in <=5 kms and 1.1% in > 5 kms, p=0.004 Significant by Chi Square test

- ✓ Skin itch/eczema: : 9.6% in <=5 kms and 1.9% in > 5 kms, p=0.004 Significant by Chi Square test
- ✓ Ocular infections: 16.9% in <=5 kms and 3.0% in > 5 kms, p=0.004 Significant by Chi Square test
- ✓ Eye irritation: 31.3 in <=5 kms and 9.1% in > 5 kms, p=0.004 Significant by Chi Square test

The prevalence of respiratory symptoms is higher in villages with multiple industries as compared to the villages with single industry.

The pollutants value monitored are below the standard value in Chandrapur (SRO & MIDC), despite more number of industries but the prevalence of respiratory symptoms is more in that area. So, the pollutants affecting could be other such as $PM_{2.5}$ or CO/CO_2 which is not monitored. And hence, those pollutants' levels are not available.

Findings of spirometry tests in adults:

- ✓ Significant difference is seen between abnormal FEV1/FVC % in study (6.8%) and control area (3.9%).(p-value by Chi-square=0.030)
- ✓ Percentage of abnormal FEV1/FVC% deviation was significantly higher in chest pain, breathlessness and asthma.
- ✓ No significant difference was observed for other symptoms

ECG findings:

ECG results were assessed in the form of two categories- normal and abnormal. Association of these results with area, distance of house from industry and cardiac symptoms was tested. However, none of these showed significant association with ECG results.

Blood Investigations Findings:

Blood tests were carried out with the purpose of assessing effect of air pollution on health with the help of haematological and biochemical blood markers.

Statistically significant difference was observed in the following parameters, in study and control area-

- ✓ Glucose- 10.17% in study area and 6.57% in control area, p-value by Chi square=0.035
- ✓ Cholesterol- 6.40% in study area and 3.63% in control area, p-value by Chi square=0.010
- ✓ Triglycerides- 20.96%in study area and 13.71% in control area, p-value by Chi square=0.000
- ✓ Bilirubin- 13.94% in study area and 9.50% in control area, p-value by Chi square=0.004
- ✓ C reactive protein- 3.29% in study area and 1.67% in control area, p-value by Chi square=0.036

Conclusion-

1. Pollution monitoring data-

1.1 Emission levels of SO2 and NOx are seen within standard values for all three years (2010-2013) Concentration of RSPM and SPM remained within standard values at Chandrapur city and MIDC area, **at remaining four sites (Rajura, Ghuggus, Tadali and Ballarshah) concentration of these particles is persistently higher than normal**.

1.2 The emission of RSPM and SPM is higher at the monitoring sites where cement, paper and steel industries are present in addition to coal mines.

1.3 Chandrapur Pollution Control Board Regional Officer has pointed out similar facts and also added that apart from industries, vehicular emission and household coal run chulhas contribute particularly more to RSPM and SPM.

2. Clinical manifestations

2.1 Presence of multiple industries in or near the village is more harmful than the single industry. Additionally, it also shows that the presence of steel, cement and paper industry in or near a village has caused more ill-effects as compared to coal and thermal industry.

2.2 School children-

Statistically significant difference is observed in prevalence of following symptoms between study and control groups:

- ✓ Dry Cough: 29.5% in Study and 21.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Night Cough: 22.3% in Study and 13.6% in Control, p=0.000 Significant by Chi Square test
- ✓ Sneezing: 17.8% in Study and 10.2% in Control, p=0.000 Significant by Chi Square test

Statistically significant difference is observed in prevalence of following symptoms between <= 5 km and > 5km distance

- ✓ Dry Cough: 31.4% in <=5 km and 19.5% in > 5 km, p=0.003 Significant by Chi Square test
- ✓ Night Cough: 23.6% in <=5 km and 15.1% in > 5 km, p=0.018 Significant by Chi Square test
- ✓ Sneezing: 19.1% in <=5 km and 10.7% in > 5 km, p=0.011 Significant by Chi Square test

2.3 Adults-

Statistically significant difference is observed in prevalence of following symptoms between study and control groups:

- ✓ Dry Cough: 19.4% in Study and 10.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Sneezing: 14.6% in Study and 6.8% in Control, p=0.000 Significant by Chi Square test
- ✓ Sore throat: 14.1 in Study and 5.4% in Control, p=0.000 Significant by Chi Square test
- ✓ Breathlessness: 13.9 in Study and 4.7% in Control, p=0.000 Significant by Chi Square test
- ✓ Asthma: 7.9 in Study and 4.2% in Control, p=0.000 Significant by Chi Square test

Statistically significant difference is observed in prevalence of following symptoms between <= 5 km and > 5km distance

- ✓ Sore Throat: 16.6% in <=5 km and 3.8% in > 5 km, p=0.000 Significant by Chi Square test
- ✓ Sneezing: 17.3% in <=5 km and 3.8% in > 5 km, p=0.000 Significant by Chi Square test
- ✓ Wheeze: 9.7% in <=5 km and 1.1% in > 5 km, p=0.000 Significant by Chi Square test
- ✓ Breathlessness: 16.0% in <=5 km and 5.3% in > 5 km, p=0.000 Significant by Chi

Significant difference is seen between abnormal FEV1/FVC % in study and control area. Percentage of abnormal FEV1/FVC% deviation was significantly higher in chest pain, breathlessness and asthma.

Percentage of abnormal FEV1/FVC % deviation was higher at other MPCB sites (7.7%) as compared to Chandrapur SRO and MIDC (3.8%).

Statistically significant difference was observed in the following blood parameters, in study and control area-

- ✓ Glucose- p-value by Chi square=0.035
- ✓ Cholesterol- p-value by Chi square=0.010
- ✓ Triglycerides-p-value by Chi square=0.000
- ✓ Bilirubin-p-value by Chi square=0.004
- ✓ C reactive protein-p-value by Chi square=0.036

2.4 Private clinics-

Statistically significant difference is observed in prevalence of following respiratory symptoms between study and control groups:

- ✓ Productive Cough: 11.9% in Study and 7.7% in Control, p=0.001 Significant by Chi Square test
- ✓ Rhinitis: 30.5% in Study and 14.3% in Control, p=0.000 Significant by Chi Square test

- ✓ Sore throat: 14.1% in Study and 5.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Breathlessness: 15.5% in Study and 2.1% in Control, p=0.000 Significant by Chi Square test
- ✓ Eye irritation: 3.8% in study and 1.4% in control, p=0.000 Significant by Chi Square test

Within study group, following symptoms showed statistically significant difference for distance less than 5Km and more than 5Km between home and industry.

- ✓ Rhinitis: 30.2% in less than 5Km and 13.4% in more than 5Km, p=0.004 Significant by Chi Square test

3 Comparison of Chandrapur with Nagpur and India-

It shows that the risk of getting respiratory symptoms and diseases like asthma is much higher in Chandrapur district than in any other place in India including Nagpur district, which is close to Chandrapur.

4 Qualitative interviews-

- ✓ From all the qualitative interviews, it was stated that the source of air pollution is not only from industries, but also from the transport associated with these industries.
- ✓ Levels of suspended particulate pollutants are considerably high, which is of public health concern, as it is associated with increased respiratory, skin and ophthalmic diseases, increased admissions and morbidities.
- ✓ Need of proper monitoring and strict action against sources of the air pollutants was reiterated.
- ✓ Intersectoral convergence for reduction of air pollution and its effects on health was also suggested.

Conclusion with respect to objectives

Overall Objective:

To determine effects of ambient air pollutants on children and adults in Chandrapur district.

This cross-sectional study brings out adequate evidence which is statistically significant that concludes there are ill effects of pollutants on health of children and adults in Chandrapur district.

It is advisable now, to consider this sample as a cohort and undertake a longitudinal panel study for next 3 years to determine and further confirm findings of this study.

Specific Objectives:

1. **To determine prevalence of respiratory symptoms and diseases (asthma, tuberculosis, Lower Respiratory Tract Infection (LRTI)/ Pneumonia, Cancer) among children studying in schools in Chandrapur district**

In children, prevalence of respiratory symptoms Dry Cough, Night Cough, Sneezing is significantly higher in the study area compared to control group. Distance of less than 5 km from Industry revealed increased prevalence.

Prevalence of respiratory symptoms is higher in Chandrapur district as a whole compared to neighbouring Nagpur district and India.

2. **To determine symptoms and diseases for which a patient visits a doctor in Chandrapur district**

In patients of Private practitioners, increased prevalence of symptoms / diseases - Productive Cough, Rhinitis,

Sore throat, Breathlessness, Eye irritation is significantly higher in the study area compared to control group.

Distance of less than 5 km from industry increased the significance of Rhinitis.

3. **To determine respiratory and cardiovascular health status of adult people living in Chandrapur district**

In adults, prevalence of Dry Cough, Sneezing, Sore throat, Breathlessness and Asthma is significantly higher in study area compared to Control area.

Distance of less than 5 km from Industry show increased prevalence.

Lung function measured by spirometry also showed significant difference between study and control area.

Prevalence of respiratory symptoms is higher in Chandrapur district as a whole compared to neighbouring Nagpur district and India.

Following table provides valuable insights into the findings of this study. These findings have been applied statistical test to see their significance.

Table 52: Conclusion of a study

System-wise Symptom / Disease	Child Data					Adult Data					Data from Private Practitioners			
	Study	Control	p-value	result		Study	Control	p-value	result		Study	Control	p-value	result
I) Respiratory Symptoms														
Dry Cough	29.5	21.3	0.000	Significant		19.4	10.3	0.000	Significant					
Productive Cough						6.10	3.00	0.001	Significant		11.9	7.7	0.001	Significant
Night Cough	22.3	13.6	0.000	Significant		8.3	6.1	0.041	Significant					
Whooping Cough	6.8	3.0	0.000	Significant										
Rhinitis											30.5	14.3	0.000	Significant
Sneezing	17.8	10.2	0.000	Significant		14.6	6.8	0.000	Significant					
Sore Throat	6.8	3.3	0.000	Significant		14.1	5.4	0.000	Significant		14.1	5.4	0.000	Significant
Wheeze						8.0	1.5	0.000	Significant					
Chest Pain	6.7	3.3	0.000	Significant										
Breathlessness	3.2	0.7	0.000	Significant		13.9	4.7	0.000	Significant					
II) Respiratory Disease														
Asthma	2.0	1.2	0.154	NS		7.9	4.2	0.000	Significant					
III) Respiratory Diagnostics														
PEFR - among children	58.9	57.5	0.506	NS										
FEV1/FVC % Devaition among						6.8	3.9	0.000	Significant					

System-wise Symptom / Disease	Child Data					Adult Data					Data from Private Practitioners			
	Study	Control	p-value	result		Study	Control	p-value	result		Study	Control	p-value	result
adults														
FVC % Deviation among adults						35.5	13.3	0.000	Significant					
IV) Cardio-Vascular Diseases														
IHD						2.6	0.3	0.000	Significant					
Hypertention						10.9	6.0	0.000	Significant					
V) Cardio-Vascular Diagnostics														
ECG						15.6	21.4	0.248	NS					
VI) Dermat symptoms														
Skin Infections						6.5	3.1	0.000	Significant		15.5	1.0	0.000	Significant
Skin Itch / Eczema						8.1	4.6	0.001	Significant					
Redness / Rash						4.4	0.9	0.000	Significant					
Ulcers						2.3	0.07	0.003	Significant					
VII) Ophthalmic symptoms														
Occular Infections						14.1	8.1	0.000	Significant					
Eye Irritation						26.8	15.4	0.000	Significant					

Findings of data from private practitioners:

The symptoms or diseases reported by practitioners were analysed based on area and distance of house from industry.

Statistically significant difference is observed in prevalence of following respiratory symptoms between study and control groups:

- ✓ Productive Cough: 11.9% in Study and 7.7% in Control, p=0.001 Significant by Chi Square test
- ✓ Rhinitis: 30.5% in Study and 14.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Sore throat: 14.1% in Study and 5.3% in Control, p=0.000 Significant by Chi Square test
- ✓ Breathlessness: 15.5% in Study and 2.1% in Control, p=0.000 Significant by Chi Square test
- ✓ Eye irritation: 3.8% in study and 1.4% in control, p=0.000 Significant by Chi Square test

For other symptoms, there was no significant difference observed. Similarly, for cardiovascular, dermatological and ophthalmological symptoms, no significant difference was observed.

Statistically significant difference was observed for rhinitis/nasal irritation for distance between home and industry; 30.2% in less than 5Km and 13.4% in more than 5Km, p=0.004 Significant by Chi Square test.

Comparison with prevalence in other studies:

Prevalence of respiratory symptoms of this study was compared with the prevalence of study sponsored by ICMR - Jindal SK. Indian study on epidemiology of Asthma, Respiratory symptoms and Chronic bronchitis (INSEARCH). September 2010. The INSEARCH study also recorded the prevalence of symptoms, as reported by the respondents, as was done for the current study.

The prevalence of respiratory symptoms are significantly higher in Chandrapur district compared with Nagpur district and national figures.

This definitely shows that, the health effects of ambient air pollution are visible at symptomatic level and for Asthma. If necessary steps are not taken at right time, the conditions may worsen.

The presence of five types of industries and the transport of products from these industries have made the district vulnerable for exposure to air pollution for many years. The data from six pollution control board monitoring sites shows that population in the district is exposed to high levels of air pollutants, both gaseous as well as particulate matter. Since the monitoring site measures the air pollutants at the level of their source of emission (chimneys of factories), actual levels of these pollutants at ground level are not available. Though the levels of gaseous air pollutants SO2 and NOx are seen to be within standard limits set by national air quality guidelines, the effect of these pollutants can be observed because of chronic exposure. Concentration

of particulate matter is much higher than the standard values, almost two to three times at most of the monitoring sites. Presence of cement, paper, steel industry or multiple industries in a village has shown higher levels of RSPM and SPM. There is no mechanism established at these monitoring sites to record levels of carbon monoxide (CO) or PM2.5 in the ambient air.

High prevalence of allergic dermatological and ophthalmic symptoms is observed, which can be associated with chronic exposure to air pollutants. Low prevalence of lung cancer or skin cancer is found, however, according to district health authorities, number of reported cases has been increased than earlier years. Though the diseases of respiratory system such as asthma or COPD show low prevalence, the symptoms which can be primitive to these diseases are far above the ground.

The progressive data at private clinics also supports the findings of adult data collected with the help of questionnaires. Higher prevalence of respiratory and cardiovascular symptoms is seen in study area than that in control area. However, since the workers in these factories are more likely to avail treatment from the industry-run hospitals, there is possibility that the actual extent of these problems can be more than is reported at these clinics.

The prevalence of respiratory symptoms as reported by the participants is much higher as compared to prevalence at national level or in the neighboring district. The relative risk of getting these symptoms is also higher by manifolds. Hence, there is an urgent need of preventive action to be taken against the causes of air pollution along with regular monitoring of air pollution.

Chapter 11:Recommendations

1. Students and adults under this study should be taken as cohort and periodically monitored over next 3 years to observe and record any deterioration in health and associated illness and performance at school.
2. Strengthening of source emission monitoring is necessary.
3. Strengthening of air quality monitoring network- Levels of PM2.5, CO and CO2 gases should also be recorded alongwith the presently monitored SO2, NOx and RSPM as these gases are also equally harmful to health.
4. Proper mechanism for enforcement and compliance of regulations related to pollution should be built.
5. Bypass road should be built for truck transport, and also the transport of industrial products should be done in closed trucks.
6. Doctors in the area to be educated to keep high index of suspicion about possible respiratory morbidity.
7. Respiratory morbidity can be made a “Notifiable Health Condition” for the medical professionals with the help of District Health Authorities, so as to get the record as well as for early and prompt action.
8. Sentinel Surveillance Centres should be established by Public Health Department wherein, the equipments like Spirometer and Flowmeter used for the current study should be part of these Sentinel Centres. The Centre at District Hospital, Chandrapur will act as Centres of Excellence, whereas other Centres will be satellite centres. The role of these Sentinel Centres is proposed below.

Sentinel Surveillance Centers

The foremost need of the hour is to establish Sentinel Surveillance Centres at the public health facilities where the MPCB monitoring sites are located i.e. Chandrapur SRO, Chandrapur MIDC, Tadali MIDC, Ghuggus, Ballarshah and Rajura.

Thus, Centres should be established at following facilities-

Table 53: Sentinel Surveillance Centres

Type of Centre	Name of health facility	MPCB site location
Centre of Excellence	General Hospital Chandrapur	Chandrapur SRO
Satellite centre	Primary Health Centre, Durgapur	Chandrapur MIDC
Satellite centre	Primary Health Centre, Tadali	Tadali MIDC
Satellite centre	Primary Health Centre, Ghuggus	Ghuggus
Satellite centre	Rural Hospital, Ballarshah	Ballarshah
Satellite centre	Rural Hospital, Rajura	Rajura

Speciality treatment will be provided at the Centre of Excellence, that is General Hospital Chandrapur. The cases which are not manageable at the satellite centres will be referred to this centre for further diagnosis and treatment. The data from all centres will be collated at the Centre of Excellence and decisions regarding appropriate interventions would be taken here.

The Surveillance Centres should impart **promotive**, **preventive** and **curative** services.

1. Target population:
   Population in the catchment area of 6 health facilities should be the target population. Cases identified in the study for respiratory & cardio-vascular symptoms & diseases, should be treated and followed up in these centres.
2. Local NGOs:
   Local NGOs should be involved in the activity and their help / support should be taken for following up the cases.
3. Awareness creation and prevention measures:
   This centre should bring all 5 stakeholders together; namely: Public Health Department, MPCB, NGOs, Industries and Community. Every stakeholder will be enrolled in awareness activities. Community will be made aware about early signs of these symptoms and will be encouraged to take treatment on time.
4. Clinical Role:
   These Centres should provide treatment to all the cases who come with resepiratory symptoms & diseases. i.e. dry cough, night cough, productive cough, sore throat, wheeze, sneezing like symptoms shuld be treated and monitored as they are precursors to the respiratory diseases Asthma and COPD. Similary, cardiovascular symptoms & diseases will be treated and monitored here. i.e. hypertension, chest pain will be treated and monitored as they are precursors to cardiovascular diseases. Other diseases or symptoms which should be monitored are ophthalmic problems (redness of eyes, eye infections) and skin problems (itching, eczema).
   Regular supply of medicines for all these symptoms and diseases should be ensured. These centres should also maintain case-wise record of all these diseases and should make its use for planning and further improving health status.

Moreover, these Centres should function as observation and monitoring mechanism for the health outcome of the people residing in the vicinity of industries with respect to changes in air pollution levels

The sample from the current study should be taken as cohort for continued observation and monitoring; along with the cases of possible ill-effects of air pollution detected in all health facilities, including government hospitals and industry-run hospitals in the vicinity of industrial areas. Regular health check-up of these cases should be done in conjunction with pulmonary function tests, ECGs and blood tests, if required.

Specific fucntions should include:

1. Capacity building of doctors and paramedics
   - ✓ For detection of illnesses / diseases due to air pollution.

- ✓ For monitoring and reporting certain parameters and illnesses related to air pollution,
- ✓ For preventive measures to be taken by the people for these effects.
- ✓ Process of reporting cases showing effects of air pollution

2. Follow up of participants in the study, showing unfavourable health effects of air pollution as well as cases reported by the health facilities in nearby areas.
3. Periodic check-up and investigations of this cohort for the effects of air pollution.
4. Advice promotive and preventive measures through awareness such as use of cloth around mouth and nose, nutrition and hygiene, conversion of coal-chulhas to non-coal chulhas to patients showing pre-disease condition or minimal effects.

Role of PROGNOSIS: PROGNOSIS will undertake training of the staff of Sentinel Surveillance Centres, assist in their establishment and roll out of proper monitoring mechanism at these Centres.

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Annexure 1: Questionnaire for school children epidemiological data

Taluka/Block: तालुक्याचे नाव:		
Name of the Village/town गावाचे/शहराचे नाव:	_____	
Name of the school शाळेचे नाव:	_____	
Type of school शाळेचा प्रकार:	Private=1खाजगी Public=2 सरकारी	☐
Address of school शाळेचा पत्ता		
Does this school belong to the study or control group ही शाळा स्टडीग्रुपमधीलआहेकीकंट्रोलग्रुपमधील?	study=1 स्टडी control=2कंट्रोल	☐
1. Result of the interview- to be filled up at the end of the interview	Interview completed -	1
	Interview partially completed –	2
	Interview not conducted due to refusal	3

Questionnaire ID: ☐☐☐☐

SECTION A- INTERVIEW DETAILS	
Name of the Interviewer	
Date of Interview Date Month Year ☐☐ ☐☐ ☐☐	Interview starting time: Hours ☐☐ Minutes ☐☐
Further details to be filled after completion of interview	
Interview completion time: Hours ☐☐ Minutes ☐☐	

	Name	**Date** Date Month Year	**Signature**
Field Supervisor			
Back Checked by			
Spot Checked by			
Data entry by			

Section-B: Demographic profile

Question Number	Question प्रश्न	Options पर्याय	Code कोड
Q.101	Name of respondent माहिती देणाऱ्याचे नाव		
Q.102	Sex of respondent माहिती देणाऱ्याचे लिंग	Male=1 Female=2	
Q.103	Age of respondent (In complete years) माहिती देणाऱ्याचे वय		
Q.104	School standard इयत्ता	1st std 2nd std 6th std 7th std	
Q.105	Social group माहिती देणाऱ्याची जात	SC=1 ST=2 OBC=3 Gerneral=4 Don't know=98 No Answer=88	
Q.106	Religion माहिती देणाऱ्याचा धर्म	Hindu=1 Muslim=2 Christain=3 Jain=4 Shikh=5 Bodhist=6 Other=77 No Answer=88 Don't know=98	
Q.107	Type of house घराचा प्रकार	Kachha=1 Pakka=2 Semi-pakka=3	
Q.108	Since how many years you have been staying here? (to be asked to the teachers) तुम्ही गेले किती वर्ष इथे राहत आहात?	5to 10 years=1 10 to 15 years =2 More than 15 years=3	
Q. 109	No. of household members कुटुंबातील सदस्यांची संख्या	Less than 3=1 3 to 5=2 6 to 10=3	
Q.100	Distance of your house from the nearest industry mentioned below (Circle the industry and then write the distance)- To be asked to the teacher खाली नमूद केलेल्या कोणत्या उद्योगांपासून तुमचे घर सगळ्यात जवळ आहे? त्याचे अंतर किती आहे? विद्याथ्याने उत्तर न दिल्यास शिक्षकांना विचारावे Steel industry Thermal industry Coal industry Paper industry Cement industry	1-5 km=1 5-10km=2 10-15km=3 15-20km=4 20-25km=5 Morethan 25km=6	

	None of the above		
Q.111	Distance of the school from the nearest industry mentioned below (Circle the industry and then write the distance) (to be asked to the teacher) खाली नमूद केलेल्या कोणत्या उद्योगांपासून तुमची शाळा सगळ्यात जवळ आहे? त्याचे अंतर किती आहे? हा प्रश्न शिक्षकाला विचारावा Steel industry Thermal industry Coal industry Paper industry Cement industry None of the above	1-5 km=1 5-10km=2 10-15km=3 15-20km=4 20-25km=5 More than 25km=6	

Section C: School performance of the student (to be asked to the teacher)

	Very good 5	Good 4	Average 3	Poor 2	Very poor 1
Academics					
Sports					
Extra curricular					
Total score					

Section D: Clinical characteristics (to be asked to the teachers if the student cannot respond)

(विद्यार्थ्यांनी उत्तर न दिल्यास शिक्षकांना विचारावे)

Question number	Question प्रश्न	Options पर्याय	Code कोड
Q. 201	No. of illness episodes in last one year मागील एका वर्षात तुम्ही किती वेळा आजारी पडलात ?	Never=1 कधीही नाही १= 2- 4 times=2 २ ते ४ वेळा २= More than 4=3 चार पेक्षा जास्त ३=	
Q.202	No. of clinical visits (OPD) in last one year मागील एका वर्षात तुम्ही किती वेळाबाह्य रुग्नालय विभागात गेलात?	1-2 times=1 १ ते २ वेळा १= 2-4 times=2 २ ते ४ वेळा २= More than 4 = 3 चार पेक्षा जास्त३=	
Q.203	Reasons for the same and its frequency (Pls encircle the system and specify the no of visits for the same) बाह्य रुग्नालयात जायचे कारण आणि किती वेळेला गेलात? Respiratory श्वसनसंस्थेविषयी Cardiovascular हृदयविकारासंबंधी Others (Pls specify) इतर	Respiratory= श्वसनसंस्थेविषयी Cardiovascular= हृदयविकारासंबंधी Others (Pls specify)= इतर	
Q.204	No. of days of hospitalization in last one year मागील एका वर्षात तुम्ही किती दिवस इस्पितळात भरती होता?	1-2 times=1 १ ते २ वेळा १= 2-4 times=2 २ ते ४ वेळा २= More than 4 = 3 चार पेक्षा जास्त३=	

Is the child currently suffering from the following? सध्या विद्यार्थ्याला खालीलपैकी कोणती लक्षणे आहेत का?			
Q.205A	Dry Cough	Yes……..1 No……2	
Q.205B	Productive Cough	Yes……..1 No……2	

Q.205C	Night Cough	Yes……..1 No……2	☐
Q.205E	Continued sneezing / Nasal irritation	Yes……..1 No……2	☐
Q.205F	Sore throat	Yes……..1 No……2	☐
Q.205G	Wheeze	Yes……..1 No……2	☐
Q.205H	Chest Pain/tightness	Yes……..1 No……2	☐
Q.205I	Foreign Bodies	Yes……..1 No……2	☐
Q.205J	Breathlessness	Yes……..1 No……2	☐
Q.205K	Asthma	Yes……..1 No……2	☐
Q.205L	Tuberculosis	Yes……..1 No……2	☐
Q.205M	LRTI/Pneumonia	Yes……..1 No……2	☐
Q.205N	Cancer	Yes……..1 No……2	☐

Anthropometric measurements			
Q.206A	Weight (Kg) वजन (किलो)		☐
Q.206B	Height (cm) उंची (सेमी)		☐
Q.206C	Skin fold thickness (mm)		☐

Physical examinations			
Q.207A	Hair (texture, color)		☐
Q.207B	Skin discoloration		☐
Q.207C	Peak expiratory flow rate		☐
Q.207D	No. of sick absentees (to be collected from the teacher's		☐

	register for children's attendance) for last 1 year विद्यार्थी आजारपणामुळे मागील एका वर्षात शाळेत किती दिवस आजारी होता?		

Annexure 2: Questionnaire for adults epidemiological data

Taluka/Block: तालुक्याचे नाव:		
Name of the Village/town गावाचे:नाव शहराचे/	_____	
Name of Gram Panchayat ग्रामपंचायतीचे नाव:	_____	
Address पत्ता:		
Does the respondent belong to study or control group? व्यक्ती स्टडी ग्रुपमधील आहे की कंट्रोल ग्रुपमधील ?	Study =1 स्टडी control=2कंट्रोल	
2. Result of the interview- to be filled up at the end of the interview	Interview completed -	1
	Interview partially completed –	2
	Interview not conducted due to refusal	3

Questionnaire ID: ☐☐☐☐

SECTION A- INTERVIEW DETAILS								
Name of the Interviewer माहिती देणारयाचे नाव:								
Date of Interview Date Month Year ☐☐ ☐☐ ☐☐		Interview starting time: Hours ☐☐ Minutes ☐☐						
Further details to be filled after completion of interview								
Interview completion time: Hours ☐☐ Minutes ☐☐								
	Name	**Date** Date Month Year						**Signature**
Field Supervisor								
Back Checked by								

Spot Checked by								
Data entry by								

Section-1: Demographic profile

Question Number	Questions प्रश्न	Options पर्याय	Code कोड
Q.101	Where are you working? तुम्ही कुठे काम करता? If answer to this question is anything between 1 to 5,then the person is rejected from the study या प्रश्नाचे उत्तर १,२,३,४ किंवा ५ या पैकी काहीही असल्यास या व्यक्तीला अभ्यासातून वगळावे	Steel industry=1 Thermal industry=2 Coal industry=3 Paper industry=4 Cement industry=5 None of the above=6	
Q.102	What is the distance of your house from the nearest industry listed below? खाली नमूद केलेल्या कोणत्या उद्योगांपासून तुमचे घर सगळ्यात जवळ आहे?आहे किती अंतर त्याचे ?)encircle the industry and write the distance) Steel industry Thermal industry Coal industry Paper industry Cement industry None of the above	1to 5 km=1 6to 10km=2 11 to 15 km=3 16 to 20km=4 21to 25km=5 More than 25km=6	
Q.103	Name of respondent माहिती देणाऱ्याचे नाव		
Q.104	Sex of respondent माहिती देणाऱ्याचे लिंग	Male=1 Female=2	
Q.105	Age of respondent (In Complete Years) माहिती देणाऱ्याचे वय		
Q.106	Social group माहिती देणाऱ्याची जात	SC=1 ST=2 OBC=3 Gerneral=4 Don't know=98 No Answer=88	
Q.107	Religion माहिती देणाऱ्याचा धर्म	Hindu=1 Muslim=2 Christain=3 Jain=4 Shikh=5 Bodhist=6 Other=77 No Answer=88 Don't know=98	
Q.108	Relationship with head of the household	Head=1 Spouse=2	

	कुटुंबप्रमुखाशी असलेले नाते	Father=3 Mother=4 Son=5 Daughter=6 Brother=7 Sister=8 Uncle=9 Ant=10 Other=77	
Q.109	No. of household members कुटुंबातील सदस्यांची संख्या	Less than 3=1 3 to 5=2 6 to 10=3	☐
Q.110	Level of education attained शैक्षणिक पात्रता	Illiterate=1 informal education=2 1st to 4th class=3 5th to 8th class=4 9th to 10th class=5 11th to 12th class=6 Graduation and above=7 Other Diploma=8	☐
Q.111	Marital status वैवाहिक स्थिती	Unmarried=1 Married=2 Widowed/Widower=3 Divorced/Separated=4 No Answer=98	☐
Q.112	Main occupation of the respondent माहिती देणारयाचा प्रमुख व्यवसाय	Unemployed= 1 Housewife =2 Daily wage worker = 3 Agricultural Labour=4 Agriculture=5 Traditional occupation=6 Salaried employee= 7 Business = 8 Retried=10 Others=77 No answer =98	☐
Q.113	Annual Income of the Family (in RS) कुटुंबाचे वार्षिक उत्पन्न	RS. ……	

Section-2: Socioeconomic profile

Q.201	Type of House **(Interviewer to observe this and make a note)** घराचा प्रकार	Kacha=1 Semi-pakka=2 Pakka=3	☐
Q.202	What type of fuel does your household mainly use for cooking?	Kerosene =1 Agriculture/crop=2	☐

	तुम्ही स्वयंपाकासाठी कोणते इंधन वापरता ? If answer to this question is 4,5 or 77 then go directly to Q.204 जर या प्रश्नाचे उत्तर ४.प्र तर असेल ७७ किंवा ५,क्र २०४ . विचारा	Coal =3 LPG gas=4 Biogas=5 Wood =6 Other=77 (Pls specify)	
Q.203	What type of cooking stove is used in your house? घरात कोणत्या प्रकारचा स्टोव्ह वापरला जातो?	Open fire/stove without chimney/hood=1 Open fire/stove with chimney/hood=2 Closed stove with chimney=3 Other=77 (Pls specify)	☐
Q.204	Where is cooking usually done? घरात स्वयंपाक कुठे केला जातो?	In a room used for living/sleeping=1 In a separate room used as kitchen=2 In a separate building used as kitchen=3 Outdoors=4 Other=77 (Pls specify)	☐

Section 3- Health events (out patient visits) - for past one year

Question number	Question	Option	Code
Q. 301	No. of illness episodes in last one year मागील एका वर्षात तुम्ही किती वेळा आजारी पडलात? If answer to this question is 1, then go to section 5:habits जर या प्रश्नाचे उत्तर १ असल्यासजा कडे ५ सेक्शन ,	Never=1 कधीही नाही १= 2- 4 times=2 २ ते ४ वेळा २= More than 4=3 चार पेक्षा जास्त ३=	☐
Q.302	No. of clinical visits (OPD) in last one year मागील एका वर्षात तुम्ही किती वेळा बाह्य रुग्नालय विभागात गेलात ?	1-2 times=1 १ ते २ वेळा १= 2-4 times=2 २ ते ४ वेळा २= More than 4 = 3 चार पेक्षा जास्त ३=	☐
Q.303	Reasons for the same and its frequency (Pls encircle the system and specify the no of visits for the same) बाह्य रुग्नालयात जायचे कारण आणि किती वेळेला गेलात ? Respiratory श्वसनसंस्थेविषयी	Respiratory= श्वसनसंस्थेविषयी= Cardiovascular= हृदयविकारासंबंधी Others (Pls specify)= इतर	☐

	Cardiovascular हृदयविकारासंबंधी Others (Pls specify) इतर		

Section-4: Health events (hospitalization) - For the period of past 1 year

Q.401	In past one yearhave you been hospitalized as a result of any major health event? मागील एका वर्षात तुम्ही मोठ्या आजारपणाने इस्पितळात भरती झाले आहात का? If answer to this question is No then go to section5: Habits जर या प्रश्नाचे उत्तर 'नाही' असेल तर सेक्शन ५ला जा	Yes=1 हो No=2 नाही	☐
Q.402	Reasons for the same and its frequency (Pls encircle the system and specify the no of visits for the same) इस्पितळात जायचे कारण आणि किती वेळा गेलात? Respiratory श्वसनसंस्थेविषयी Cardiovascular हृदयविकारासंबंधी Others (Pls specify) इतर	Respiratory= श्वसनसंस्थेविषयी Cardiovascular= हृदयविकारासंबंधी Others (Pls specify)= इतर	☐
Q.403	Which type of hospital was it? कोणत्या प्रकारचे इस्पितळ होते ? (multiple answers possible))एकापेक्षा अधिक उत्तरे शक्य(	Government=1 सरकारी १= Private=2 खाजगी २= Charitable trust=3 धर्मादाय संस्था ४= Don't know=98 माहित नाही ४=	☐
Q.404	Did you undergo any kind of procedure as a result of this illness? या आजारपणामुळे तुमच्यावर कोणती प्रोसिजर झाली का ? **Procedures**- Bronchoscopy Laparoscopy Angiography Angioplasty	Yes=1 हो=१ No=2 नाही=२	☐

Q.405	What was the procedure? ही प्रोसिजर कोणती होती?	Respiratory=1 श्वसनसंस्थेविषयी Cardiovascular=2 हृदयविकारासंबंधी Others (Pls specify)= 3 इतर	
Q.405	Did you undergo any kind of surgery as a result of this illness? या आजारपणामध्ये तुमची कुठली शस्त्रक्रिया झाली का ?	Yes=1 हो १= No=2 नाही २=	
Q.406	For how many times, you were admitted to the hospital for more than 24 hrs? तुम्ही किती वेळेला २४ तासापेक्षा अधिक काळ इस्पितळात भरती होता?	1-2 times=1 १ ते २ वेळेला१= 2-4 times=2 २ ते ४ वेळेला २= More than 4 = 3 चारपेक्षा अधिक३=	
Q.407	What was the outcome of this disease? या आजाराचा शेवट कसा झाला?	Permanent disability=1 कायमचे अपंगत्व १= Temporary disability=२ तात्पुरते अपंगत्व २= No disability=3 अपंगत्व नाही ३=	

Section-5: Habits

Q.501	Do you use tobacco in any form? तुम्ही तंबाखू खाता का? If answer to this question is no, then go directly to Q.404 या प्रश्नाचं उत्तर 'नाही' असल्यास प्र.क्र.४०४ कडे जा	Yes=1 हो १= No=2 नाही २=	
Q.502	If yes, in which form do you use it? तुम्ही कुठल्या प्रकारची तंबाखू वापरता?	Smoking=1 Chewing=2 Applying=3 Snorting=4 Other=77 (Pls specify)	
Q.503	How frequently do you use tobacco? तुम्ही तंबाखू किती वारंवार खाता?	Never in the past one month=1	

		मागील एका महिन्यात एकदाही नाही=१ Only once in the past one month =2 मागील एका महिन्यात एकदा=२ 2-3 times in the past one month =3 मागील एका महिन्यात २-३ वेळा=४ About once a week =4 आठवड्यातून एकदा=४ 2-3 times a week =5 आठवड्यातून २-३ वेळा=५ once daily =6 दिवसातून एकदा=६ 2-3 times daily =7 दिवसातून २-३ वेळा=७ 4 or more times daily =8 दिवसातून ४ वेळा=८ Don't know =98 माहित नाही=९८ No answer=88 उत्तर नाही=८८	
Q.504	Do you consume alcohol? तुम्ही दारू पिता का? If answer to this question is no, then go directly to section 6:signs and symptoms जर या प्रश्नाचे उत्तर 'नाही' असेल तर सेक्शन ६ कडे जा	Yes=1 होय १= No=2 नाही २=	☐
Q.505	How frequently do you consume alcohol? तुम्ही दारू किती वारंवार पिता?	Never in the past one month=1 मागील एका महिन्यात एकदाही नाही=१ Only once in the past one month =2 मागील एका महिन्यात एकदा=२ 2-3 times in the past one month =3 मागील एका महिन्यात २-३ वेळा=४ About once a week =4 आठवड्यातून एकदा=४ 2-3 times a week =5 दिवसातून २-३ वेळा=७ Once daily =6 दिवसातून एकदा=६	☐

		2-3 times daily =7 दिवसातून २-३ वेळा=७ 4 or more times daily =8 दिवसातून ४ वेळा=८ Don't know =98 माहित नाही=९८ No answer=88 उत्तर नाही=८८	

Section-6: Signs & symptoms रोगाची लक्षणे

Are you currently suffering from the following?

तुम्हाला सध्या खालील लक्षणे दिसत आहेत का?

General / Unspecified Symptoms

	Signs & symptoms लक्षणे	Yes=1 होय १= No=2 नाही २=	Code कोड
Q.601	Fever		
Q.602	Headache/ Bodyache		
Q.603	Loss of appetite		
Q.604	Accident/ Injury		
Q.605	General Weakness		
Q.606	Glands Lymphadenopathy (cervical, inguinal, axillary)		
Q.607	Weight loss (less than 10% in last month)		
Q.608	Pallor		

Respiratory Symptoms

Q.609	Dry Cough		
Q.610	Productive Cough		
Q.611	Night Cough		

Q.612	Continued sneezing/ Nasal irritation		
Q.613	Sore throat		
Q.614	Wheeze		
Q.615	Chest Pain/tightness		
Q.616	Foreign Bodies		
Q.617	Breathlessness		
Q.618	Asthma		
Q.619	COPD		
Q.620	Tuberculosis		
Q.621	LRTI/Pneumonia		

Digestive Symptoms

Q.622	Loose motions		
Q.623	Constipation		
Q.624	Acidity/heart burn		
Q.625	Jaundice		
Q.626	stomach Pain		

Cardiovascular Symptoms

Q.627	Breathlessness		
Q.628	Chest Pain/tightness		
Q.629	Giddiness		
Q.630	Ischemic heart disease		
Q.631	Hypertension		
Q.632	Congestive heart failure		
Q.633	Valvular diseases		
Q.634	Pedal edema		
Q.635	Peripheral vascular disease		

Q.636	Pallor		

Dermatology Symptoms

Q.637	Wound		
Q.638	Ulcers (non healing)/Boils/Burn		
Q.639	Redness/Rush/Urticaria		
Q.640	Skin itch/Eczema		
Q.641	Skin Infections		
Q.642	Scabies/Lice		

Ear Symptoms

Q.643	Ear ache		
Q.644	Ear Discharge		
Q.645	Hearing defects		

Ophthalmology defects

Q.646	Eye irritation/Redness		
Q.647	Ocular Infections		
Q.648	Refractory errors		
Q.649	Congenital anomalies		
Q.650	Cataract		

Endocrinology Symptoms

Q.651	Diabetes		
Q.652	Obesity		
Q.653	Thyroid disorders		
Q.654	Goiter		

Neurology Symptoms

Q.655	Dizziness/Giddiness/Vertigo		
Q.656	Stroke/CVA		
Q.657	Tremors		
Q.658	Tingling/ Numbness		
Q.659	Tumors		
Q.660	Convulsions		
Q.661	Syncopal attacks		

Musculoskeletal Symptoms

Q.662	Sprains,Muscle Aches		
Q.663	Fractures		
Q.664	Arthritis/ Joint Swelling		

Urology Symptoms

Q.665	Dysuria/Burning micturition		
Q.666	Haematuria		
Q.667	Calculi		
Q.668	Urine retention		
Q.669	Urine Incontinence		
Q.670	Infections		
Q.671	Tumors		

Psychological Disturbances

Q.672	Depression		
Q.673	Anxiety		
Q.674	Irritability		
Q.675	Insomnia		

Section 7: Anthropometric measurements

Q.701	Height (cm)उंची		
Q.702	Weight (Kg)वजन		
Q.703	Skin fold thickness (mm)		

Annexure 3: Tool for collection of data from private practitioners

Questionnaire Id

Prevalance of symptoms and signsfor which a patient visits a doctor in Chandrapur District over 1 month.										
Taluka										
Name of the practitioner										
Date										
MBBS//BAMS//BUMS//BHMS//MD//DNB Med//MD/DNB Peds/DCH//Others (Specify)										
Total No. of patients Examined on that day										
Patient Number	1	2	3	4	5	6	7	8	9	10
Gender (M/F)	1	2	3	4	5	6	7	8	9	10
Age (in Yrs)	1	2	3	4	5	6	7	8	9	10
Smoking (Y=1/N=2)	1	2	3	4	5	6	7	8	9	10
Tobacco Chewing(Y=1/N=2)	1	2	3	4	5	6	7	8	9	10
Alcohol Consumtion(Y=1/N=1)	1	2	3	4	5	6	7	8	9	10
General / Unspecified Symptoms Yes=1, No=2										
Fever	1	2	3	4	5	6	7	8	9	10
Headache/ Bodyache	1	2	3	4	5	6	7	8	9	10
Loss of appetite	1	2	3	4	5	6	7	8	9	10
Accident/ Injury	1	2	3	4	5	6	7	8	9	10
General Weakness	1	2	3	4	5	6	7	8	9	10
Lymphadenopathy (Cervical, inguinal, axillary)	1	2	3	4	5	6	7	8	9	10
loss of weight	1	2	3	4	5	6	7	8	9	10
Anemia	1	2	3	4	5	6	7	8	9	10
Cancer	1	2	3	4	5	6	7	8	9	10
Respiretory Symptoms										
Dry Cough	1	2	3	4	5	6	7	8	9	10
Productive Cough	1	2	3	4	5	6	7	8	9	10
Night Cough	1	2	3	4	5	6	7	8	9	10
Whooping Cough	1	2	3	4	5	6	7	8	9	10
Rhinitis/ Nasal irritation	1	2	3	4	5	6	7	8	9	10
Sore throat	1	2	3	4	5	6	7	8	9	10
Wheeze	1	2	3	4	5	6	7	8	9	10
Crepitation	1	2	3	4	5	6	7	8	9	10
Chest Pain/tightness	1	2	3	4	5	6	7	8	9	10
Foreign Bodies	1	2	3	4	5	6	7	8	9	10
Breathlessness	1	2	3	4	5	6	7	8	9	10
Asthma	1	2	3	4	5	6	7	8	9	10
COPD	1	2	3	4	5	6	7	8	9	10
Tuberculosis	1	2	3	4	5	6	7	8	9	10
LRTI/Pneumonia	1	2	3	4	5	6	7	8	9	10
Cancer	1	2	3	4	5	6	7	8	9	10
Digestive Symptoms										
Diarrhoea	1	2	3	4	5	6	7	8	9	10
Constipation	1	2	3	4	5	6	7	8	9	10
Gastritis	1	2	3	4	5	6	7	8	9	10
Hepatitis	1	2	3	4	5	6	7	8	9	10
Abdominal Pain	1	2	3	4	5	6	7	8	9	10
Cancer	1	2	3	4	5	6	7	8	9	10

Cardiovascular Symptoms										
Breathlessness	1	2	3	4	5	6	7	8	9	10
Chest Pain/tightness	1	2	3	4	5	6	7	8	9	10
Giddiness	1	2	3	4	5	6	7	8	9	10
Ischemic heart disease	1	2	3	4	5	6	7	8	9	10
Hypertension	1	2	3	4	5	6	7	8	9	10
Congestive heart failure	1	2	3	4	5	6	7	8	9	10
Valvular diseases	1	2	3	4	5	6	7	8	9	10
Pedal edema	1	2	3	4	5	6	7	8	9	10
Peripheral vascular disease	1	2	3	4	5	6	7	8	9	10
Anemia	1	2	3	4	5	6	7	8	9	10
Dermatology symptoms and signs										
Wound	1	2	3	4	5	6	7	8	9	10
Ulcers (non healing)/Boils/Burn	1	2	3	4	5	6	7	8	9	10
Redness/Rash/Urticaria	1	2	3	4	5	6	7	8	9	10
Atopic dermatitis/Eczema	1	2	3	4	5	6	7	8	9	10
Skin Infections	1	2	3	4	5	6	7	8	9	10
Scabies/Lice	1	2	3	4	5	6	7	8	9	10
Ear Symptoms										
Ear ache	1	2	3	4	5	6	7	8	9	10
Ear Discharge	1	2	3	4	5	6	7	8	9	10
Hearing defects	1	2	3	4	5	6	7	8	9	10
Ophthalmology Symptoms										
Eye irritation/Redness	1	2	3	4	5	6	7	8	9	10
Ocular Infections	1	2	3	4	5	6	7	8	9	10
Congenital anomalies	1	2	3	4	5	6	7	8	9	10
Refractory errors	1	2	3	4	5	6	7	8	9	10
Cataract	1	2	3	4	5	6	7	8	9	10
Glaucoma	1	2	3	4	5	6	7	8	9	10
Endocrinology Symptoms										
Diabetes	1	2	3	4	5	6	7	8	9	10
Obesite	1	2	3	4	5	6	7	8	9	10
Thyroid disorders	1	2	3	4	5	6	7	8	9	10
Goitre	1	2	3	4	5	6	7	8	9	10
Neurology Symptoms										
Dizziness/Giddiness/Vertigo	1	2	3	4	5	6	7	8	9	10
Stroke/CVA	1	2	3	4	5	6	7	8	9	10
Tremors	1	2	3	4	5	6	7	8	9	10
Tingling/ Numbness	1	2	3	4	5	6	7	8	9	10
Tumors	1	2	3	4	5	6	7	8	9	10
Convulsions	1	2	3	4	5	6	7	8	9	10
Syncopal attacks	1	2	3	4	5	6	7	8	9	10
Musculoskeletal Symptoms										
Sprains,Muscle Aches	1	2	3	4	5	6	7	8	9	10
Fractures	1	2	3	4	5	6	7	8	9	10
Arthrits/ Joint Swelling	1	2	3	4	5	6	7	8	9	10
Female Genital Symptoms										
Pregnancy related issues	1	2	3	4	5	6	7	8	9	10
Infertility/Sterility	1	2	3	4	5	6	7	8	9	10
Dysmennorhea	1	2	3	4	5	6	7	8	9	10
Menorrehgia	1	2	3	4	5	6	7	8	9	10
STDs/Infections	1	2	3	4	5	6	7	8	9	10
Tumors	1	2	3	4	5	6	7	8	9	10

Male Genital Symptoms

STDs	1	2	3	4	5	6	7	8	9	10
Congenital anomalies	1	2	3	4	5	6	7	8	9	10
Infertility/erectile dysfunction	1	2	3	4	5	6	7	8	9	10
Prostatic Hyperplasia	1	2	3	4	5	6	7	8	9	10
Tumors	1	2	3	4	5	6	7	8	9	10
Hernia	1	2	3	4	5	6	7	8	9	10
Hydrocele	1	2	3	4	5	6	7	8	9	10

Urology Symptoms

Dysuria/Burning micturition	1	2	3	4	5	6	7	8	9	10
Haematuria	1	2	3	4	5	6	7	8	9	10
Calculi	1	2	3	4	5	6	7	8	9	10
Urine retention	1	2	3	4	5	6	7	8	9	10
Urine Incontinence	1	2	3	4	5	6	7	8	9	10
Infections	1	2	3	4	5	6	7	8	9	10
Tumors	1	2	3	4	5	6	7	8	9	10

Psychological Disturbances	1	2	3	4	5	6	7	8	9	10
Depression	1	2	3	4	5	6	7	8	9	10
Anxiety	1	2	3	4	5	6	7	8	9	10
Irritability	1	2	3	4	5	6	7	8	9	10
Insomnia	1	2	3	4	5	6	7	8	9	10

Health resorce utilization (in the part 1year)

No.of days hospitalized	1	2	3	4	5	6	7	8	9	10
No.of days in ICU	1	2	3	4	5	6	7	8	9	10
No.of clinic visits	1	2	3	4	5	6	7	8	9	10
No.of emergency visits	1	2	3	4	5	6	7	8	9	10
No.of days of absenteeism	1	2	3	4	5	6	7	8	9	10

Occupation: (There may be more then one answer. If so,Check all that apply) 1.Coal Mine 2.Cement Factory 3.Paper Mill 4.Thermal Power Plant 5.Steel Plant 6.Other (Specify)	1	2	3	4	5	6	7	8	9	10
Distance of house from nearest industry (kms). Name the industry and write the distance	1	2	3	4	5	6	7	8	9	10

Obstetric history for female patients