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सत्यमेव जयते
Ministry of Health
& Family Welfare

National Centre for
Diseases Control

IMPACT OF AIR POLLUTION ON HEALTH

A COMPENDIUM OF INDIAN STUDIES

NATIONAL PROGRAM ON CLIMATE CHANGE AND HUMAN HEALTH

National Centre for Diseases Control
Directorate General of Health services
Ministry of Health & Family Welfare
Government of India

Compendium of Indian Studies on Impact of Air Pollution on Health Impact

1. Introduction/ Background

Severe air pollution is identified as a public health emergency and an important risk factor for high morbidity and mortality. Most air pollution is man-made and occurs from poor combustion of fossil or biomass fuels (e.g. exhaust fumes from cars, furnaces or wood stoves).The main cause of indoor air pollution is inefficient fuel combustion from rudimentary technologies used for cooking, heating and lighting. Radon and chemical pollutants from building materials and cleaning products also cause indoor air pollution and impact health.

The health risks associated with particulate matter of less than 10 and 2.5 microns in diameter (PM10 and PM2.5) are especially well documented. PM is capable of penetrating deep into lung passageways and entering the bloodstream causing cardiovascular, cerebrovascular and respiratory impacts. In 2013, it was classified as a cause of lung cancer by WHO's International Agency for Research on Cancer (IARC). It is also the most widely used indicator to assess the health effects from exposure to ambient air pollution.

The major outdoor pollution sources include vehicles, power generation, building heating systems, agriculture/waste incineration and industry. In addition, more than 3 billion people worldwide rely on polluting technologies and fuels (including biomass, coal and kerosene) for household cooking, heating and lighting, releasing smoke into the home and leaching pollutants outdoors.

Air quality is closely linked to earth's climate and ecosystems globally. Many of the drivers of air pollution (i.e. combustion of fossil fuels) are also sources of high CO2emissions. Some air pollutants such as ozone and black carbon are short-lived climate pollutants that greatly contribute to climate change and affect agricultural productivity. Policies to reduce air pollution, therefore, offer a "win-win" strategy for both climate and health, lowering the burden of disease attributable to air pollution, as well as contributing to the near- and long-term mitigation of climate change *(http://www.who.int/airpollution/ambient/about/en/)*. The pollutants with the strongest evidence of health effects are particulate matter (PM), ozone (O3), nitrogen dioxide (NO2) and sulphur dioxide (SO2).Although most emissions of ambient air pollution are from local or regional sources, under certain atmospheric conditions air pollution can travel long distances across national borders over time scales of 4-6 days, thereby affecting people far away from its original source.

Urban outdoor air pollution can be an important contributor to the indoor air quality, especially in highly ventilated homes, or in homes near pollution sources. Similarly, indoor air pollution sources may also be important causes of urban outdoor air pollution, especially in cities where many homes use biomass fuels or coal for heating and cooking. Poor urban planning, which leads to sprawl and over-dependence on private vehicle transport, is also a major factor in accelerated pollution emissions.

There is now growing evidence that health effects of air pollution have no threshold/ cutoff within the studied range of ambient air pollution values. Health effects can even occur at PM2.5 background values.

Public health recognizes air pollution as an important determinant of health, especially in developing countries. There is significant inequality in the exposure to air pollution and related health risk: air pollution combines with other aspects of the social and physical environment to create a disproportional disease burden in less affluent parts of society.

Air pollution can affect our health in many ways with both long and short term effects. On the one hand urban outdoor air pollution increases the risk of acute (e.g. pneumonia) and chronic (e.g. lung cancer) respiratory disease as well as cardiovascular disease. While individuals exposed chronically to high levels of particulate matter are at increased risk for cardiovascular disease.

Different groups of individuals are affected by air pollution in different ways. More severe health impacts are seen among those people who are already ill. In addition, more vulnerable populations like children, the elderly and those households with lower incomes and limited access to health care are more susceptible to the adverse effects from exposure to air pollution. Asthmatics are at an increased risk of an asthma attack on a single day with higher ground-level ozone concentrations.

There is a close, quantitative relationship between exposure to high concentrations of small particulates (PM10 and PM2.5) and increased mortality or morbidity, both daily and over time. Conversely, when concentrations of small and fine particulates are reduced, related mortality will also go down – presuming other factors remain the same. This allows policymakers to project the population health improvements that could be expected if particulate air pollution is reduced. Small particulate pollution have health impacts even at very low concentrations – indeed no threshold has been identified below which no damage to health is observed. Therefore, the WHO 2005 guideline limits aimed to achieve the lowest concentrations of PM possible. The guideline value (2005) defined by WHO for fine particulate matter (PM10) and coarse particulate matter (PM2.5) are 10 $\mu g/m^3$ and 20 $\mu g/m^3$ (annual mean) respectively. The National Ambient Air Quality Standards (2009) for fine and coarse particulate are 40 $\mu g/m^3$ and 60 $\mu g/m^3$ (annual weighted average).

There are several international estimates available on impact on air pollution and health. WHO estimates that around 7 million people die every year from exposure to fine particles in polluted air that penetrate deep into the lungs and cardiovascular system, causing diseases including stroke, heart disease, lung cancer, chronic obstructive pulmonary diseases and respiratory infections, including pneumonia. Ambient air pollution accounts for an estimated 4.2 million deaths per year due to stroke, heart disease, lung cancer and chronic respiratory diseases. 3.8 million deaths occur every year as a result of household exposure to smoke from dirty cookstoves and fuels (*available at https://www.who.int/airpollution/en/ accessed on 29 Oct 2018*).

The Lancet Commission on pollution and health, reports that air pollution is responsible for 6·5 million (72%) of 9 million deaths per year from all types of pollution. Southeast Asia, which includes India, had the greatest numbers of pollution-related deaths.Air pollution is a critical risk factor for noncommunicable diseases (NCDs), causing an estimated one-quarter (24%) of all adult deaths from heart disease, 25% from stroke, 43% from chronic obstructive pulmonary disease and 29% from lung cancer. (*available on https://www.who.int/news-room/detail/02-05-2018-9-out-of-10-people-worldwide-breathe-polluted-air-but-more-countries-are-taking-action accessed on 29 Oct 2018*). The Lancet Commission makes it clear that the adverse health effects caused by pollution are preventable and suggests potential preventive measures and action plans. Bold, open-minded, and inclusive action plans at various levels, including political, are necessary for successful implementation of the strategies proposed in the Commission.

Estimates for India show average country exposure of PM 2.5 (*Global Health Observatory Data Repository*) for Rural (55.9 µg) , Urban (68.0 µg) and Total (65.2 µg). It is estimated that 0.62 million deaths are attributable to air pollution in India due to ARI, COPD, Lung Cancer, IHD and Stroke. According to WHO Air Quality Database 2018 (of 4300 cities from 108 countries), based on average level of particulate matter (PM2.5), nine out of top 10 worst polluted cities in the world, are in India. These are Kanpur, Faridabad, Gaya, Varanasi, Patna, Delhi, Lucknow, Agra and Gurgaon.

Based on the Source Apportionment Studies carried out in six cities in India levels of PM10and PM2.5in the ambient air were significantly high irrespective of the type of locations. Even background locations indicate presence of considerable levels of particulates, which could be occurring naturally and/or due to transport of finer dust from other settlements surrounding the cities. The concentrations of these pollutants are relatively higher at kerbside/roadside locations. While vehicles contribute significantly at all the locations, their contributions at kerbside locations are comparatively higher. Winter and post monsoon seasons had been found most critical when standard are exceeded at a higher rate than in the summer months. PM pollution problem is severe and NO2 is the emerging pollutant. These two pollutants require immediate attention to control their emissions. (*Air quality monitoring, emission inventory and source apportionment study for Indian cities 2010, MoEF&CC*).

While ambient air pollution affects developed and developing countries alike, low- and middle-income countries experience the highest burden, with the greatest toll in the WHO Western Pacific and South-East Asia regions.Policies and investments supporting cleaner transport, energy-efficient housing, power generation, industry and better municipal waste management can effectively reduce key sources of ambient air pollution.

A steering Committee on Air Pollution and Health was constituted under Additional Secretary (Health) in MoHFW. To tackle the problem of air pollution an Environment Health & Climate Change Cell was established in Dte. General of Health Services under Public Health. A Centre for Environment & Occupational Health was established in National Centre for Disease Control (NCDC),

In the light of international estimates available on burden of disease due to air pollution it was felt necessary to take stock of data from Indian studies on health impact of air pollution. A high level Committee was, therefore, constituted in MoHFW under the Chairmanship of Dr NS Dharmshaktu, Princpal Advisor MoHFW to develop a Compendium of studies on air pollution and health impact in Indian context. The Objectives for the Committee were as follows:

1. Undertake literature review of available Indian studies on air pollution and health and prepare a compendium of abstracts of all relevant studies in Indian context
2. Identify actionable points and recommendations for MoHFW, implementation by health sector, that emerge from the studies
3. Any other task assigned by the Chair

http://www.who.int/airpollution/ambient/health-impacts/en/

2. Methodology

To collect information on studies conducted on air pollution and its health impact in Indian context and key findings from these studies a format/ proforma was circulated via email to all important stakeholders. Many of them have reported significant findings and have initiated studies such as Indian Council of Medical research (ICMR), NIOH, Central Pollution Control Board, (CPCB), State Pollution control Boards, WHO, TERI, PGI Chandigarh and AIIMS. Besides, a National Consultation was also held on 3-5 October 2018, on Burden of Disease due to air pollution and to prepare Compendium of studies on air pollution and health wherein presentations were made by a variety of aforementioned stakeholders including WHO & World Bank on Indian studies undertaken.

The studies and the findings reported were reviewed and the abstracts are compiled in ensuing section.

4. Studies on Air Pollution & Health Impact in Indian Context

Upon review of various studies submitted to the committee the following abstracts of studies completed or ongoing have been compiled.

Title of Study	Objectives	Salient findings/ Preliminary findings	Outcome/Publication/ Source of reference/ status of project
I) ICMR			
1. Effect of Outdoor Air Pollution on Acute Respiratory Symptoms in Delhi: A Multisite Study.	To Study the association of acute respiratory symptoms with changes in outdoor air quality and weather variables.	Data collection is being done from June 2017 at 5 centre, AIIMS- Pulmonary Medicine department, AIIMS-Paediatrics department, Vallabhbhai Patel Chest Institute, Kalawati Saran Children's Hospital and National Institute of Tuberculosis and Respiratory Diseases for a period of 1 year 6 months. Emergency visits data are being collected in Paediatrics and adult population and these will be correlated with ambient air pollution data from DPCB. Study is an ongoing study and result are expected to be available in March 2019. A total of 44306 emergency visits has been screened for adult population and 45275 for paediatrics population from June-Dec, 2017.	Ongoing project

2. Magnitude And Impact Of Indoor Air Pollution On Morbidity Related To Chronic Obstructive Pulmonary Disease And Bronchial Asthma In Indian Women.	1-To quantify exposure to various indoor air pollutants from solid fuel combustion smoke, both particulate and gaseous, among women with COPD and asthma. 2- To study the magnitude of association of such exposure with selected health outcomes, both general and chronic respiratory disease-specific, in these women. 3- To identify potentially useful biomarkers relating degree of exposure and health outcomes in women with COPD and asthma. 4- To determine if effective reduction in amount of exposure to solid fuel smoke, resulting from accompanying interventions is associated with improvement in specified health outcomes in women with COPD and asthma. 5-To examine behavioural factors that can modify disease severity and morbidity among women with COPD and asthma. 6- To assess role of gene-environment interactions in women with COPD and asthma exposed to solid fuel smoke	This study was carried out in 30 villages in Fatehgarh Sahib district in Punjab. A cohort of 100 adult women exposed to household air pollution from use of biomass fuel for cooking, and having clinically and spirometrically diagnosed chronic respiratory diseases (asthma or COPD) has been established. A matched control population of similarly exposed women not having asthma/COPD is also available. These women have undergone detailed baseline evaluation for exposure and clinical variables, and are currently under follow-up. They can be used to conduct further longitudinal or intervention studies to assess clinical impacts of household air pollution, and its replacement using cleaner fuels. The collected blood and urine samples will be used for studying biomarkers of exposure; these results will be shortly available once the analysis of these samples is complete.	Ongoing project

3. Impact of Meteorological changes and Air Pollution on Respiratory Health and Morbidity: A Retrospective Multicentre Study.	1-To Investigate Association, if any, between the number of patients attending the outpatient Clinics and Prevailing weather profile 2-To correlate the profile and number of patients being admitted to Medical and Respiratory wards with weather conditions. 3-To investigate association, if any, between the numbers of patients with respiratory emergencies requiring admission to emergency Ward or Respiratory ICU, and weather conditions. 4-To analyze synergy between weather and air pollution variables on hospital visits and mortality related to respiratory diseases.	Findings not available	Multicentre Ongoing Project started on 01.3.2018
4. Effects of Indoor Air Pollution on Women and Children in India.	1-To determine the distribution pattern of consumption of cooking fuel(e.g., biomass, coal, kerosene, and liquefield petroleum gas – LPG) by urban slum dwellers in different parts of the country. 2-A suitable proportion of target slum population from the selected city will be statistically determined. The Selection will be based upon geographical location, number, of slums and dweller, consumption of type of cooking fuel, characteristics of slum population etc. This will be done using district wise sample survey with guidance from national source books. 3-To characterize the exposures of women and children to find and ultrafine (nanoparticle) particulate matter from	Indoor Air pollution (IAP) is a significant cause of morbidity and mortality. Fuels used for daily cooking are important pollution sources in the indoor environment. The study was carried out for evaluating indoor air pollution exposure and respiratory health effect in primary cooks and their children < 10 years residing in slum areas and suing kerosene and LPG as primary cooking fuel. A total of 1310 houses enrolled from six locations of low income groups covering all the zones of the Ahmadabad city. Area wise description regarding the demographics, housing characteristics and activities of the subjects were recorded in pre tested questionnaire. As per the project protocol, the medical examination, pulmonary Function Test (PFT), indoor air monitoring data and sputum samples were collected from the houses selected on the basis of questionnaire survey. Informed	Completed

	domestic fuel combustion using the exposure metrics of mass, number, and surface area concentration and to study the relationships among these metrics. 4-To evaluate the impact of nanoparticle exposures on respiratory health status using both traditional spirometric methods to evaluate lung function parameters (FEV1, FVC and PEFR) and cytokine expression profiles in sputum samples as biological markers of response to these exposures using protein array technology.	consent was obtained from each primary cook participated in the study. The sputum samples (N=180) from fuel users were collected and analyzed for the presence of 10 inflammatory cytokines level namely IL-1, IL-2, IL-3, IL-4, IL-8, IL-6, IL-10, TNF-a, IL-12p70 , IFN-y, Rantes and Found that IL-8, TNF-a cytokines levels were observed increased in kerosene using subjects, whereas IFN-y was observed higher in LPG using subjects. Finding of study revealed that during the cooking hours the concentrations of all the pollutants increases. In comparison of LPG using houses , different size particulate matter concentration, particles, CO and CO2 were found higher in the houses using kerosene, Medical examination revealed that maximum families using Kerosene as cooking fuel found anaemic , suffering from tuberculosis, asthma, chronic bronchitis, recurrent cough and cold. The reproductive health history of primary cooks shows that maximum still birth, child death, abortion and child congenital defect were observed in the population residing in slum area located near industrial area. Result of spirometry test shows that, out of 571 primary cooks, 31 had abnormal PFT. Restrictive type abnormality found in 26 primary cooks. While the obstructive type abnormalities found in 5 primary cooks. Majority of subjects were kerosene user.	

5. Impact of Meteorological changes and Air Pollution on Respiratory Health and Morbidity: A Retrospective Multicentre Study.	1-To Investigate Association, if any, between the number of patients attending the outpatient Clinics and Prevailing weather profile 2-To correlate the profile and number of patients being admitted to Medical and Respiratory wards with weather conditions. 3-To investigate association, if any, between the numbers of patients with respiratory emergencies requiring admission to emergency Ward or Respiratory ICU, and weather conditions. 4-To analyze synergy between weather and air pollution variables on hospital visits and mortality related to respiratory diseases.	Not available	Multicentre Ongoing Project started on 01.3.2018
6. Multi – centric Collaborative study on the impact of Environmental changes and Ultra Voilet Radiation (UVR) exposure on ocular health in India (Phase-I).	1-To estimate the UVR in National Capital Region of the Country 2-To study the effect of environmental factors and UV A& B radiation, suspended particles on the prevalence and /or exacerbation of eye diseases like cataract, dry eye, pterygium, and vernal keratoconjunctivitis in National Capital Region of the country 3-To collect the existing data on prevalence of eye diseases with available measurements of UVR and suspended particles in the initial first year of the project and subsequently plan a long term monitoring mechanism	The stratospheric ozone depletion with the potential increase in the solar ultraviolet radiation (UVR) has emerged as one of the most important effects of global change. If the eye is exposed to excessive oxidative stress due to UVR and ozone exposure, the scavengers normally present in association of ocular conditions; with the environmental factors a cross sectional study was done that aimed at estimating the role of ultraviolet rays in national Capital Region (NCR), the North East region, hilly areas and Coastal areas of the country and also to determine the effect of environmental factors and UVA & B radiation, suspended particles on the prevalence and / or exacerbation of eye diseases like cataract, dry eye, pterygium and vernal keratoconjunctivitis (VKC) in all the study regions of the country. The study intended to cover 18000 (minimum 14,000) population in 35 clusters with	Completed

		population of 400-600 in each cluster. The study population consisted of people more than 40 years for detailed eye and demographic information and population less than 15 years in children for screening for vernal keratoconjuctivitis. The major findings reported from the study in NCR were that amongst total of 18015 participants enumerated, 3595 underwent detailed ocular examination. Amongst these 3595 people, the prevalence of cataract was 1080(30.4%), dry eye was 817(22.7%) and pterygium was 403 (11.2%) . The association of ocular diseases with various risk factors showed that on unavailable analysis there was a significant association of cataract, dry eye and pterygium with age and sun exposure and even on multivariable analysis the association remained significant for all these 3 ocular diseases. All these 3 diseases namely cataract, dry eye and pterygium were found more in people with increased smoke pact year > 5 y4ars and exposure to unsafe kitchen fuel more than 15 years. To conclude, a general awareness among the people should be created regarding the use of head gear, UV protective glasses, good and safe kitchen fuel, measures to reduce environmental pollution , stop smoking encourage diet rich in antioxidants etc. to prevent from harmful effect of ultraviolet radiation and other environmental risk factors.	

7. Multi – centric Collaborative study on the impact of Environmental changes and Ultra Voilet Radiation (UVR) exposure on ocular health in India (Phase-II).	1-To Assess the association of exposure to Ultra Viloet Radiation (UVR), and aerosols with cataract, dry eye, pterygium in adults and VKC in children in urban and hilly areas of India. 2- To assess the occurrence of exacerbation of VKC along with its correlation with variability in air quality of urban areas of India. 3-To assess the cumulative incidence and progression of cataract, dry eye, and pterygium in population more than 40 years and vernal keratoconjunctivitis (VKC) in children aged less then 15 years, in rural cohort. 4-To determine the effect of aerosol loading and surface reflectivity on UV flux in urban areas on India. 5- To synthesize a statistical model (using measured UV radiation data) to forecast the UV radiation over urban areas of India.	Not available	Ongoing project started on 01-03-2018.
8. (ICMR) Center for Advanced Research on Environmental Health Air Pollution: (ICMR-CAR, SRU). Tamil Nadu Air Pollution and Health Effects (TAPHE) study.	1-Establishing relationships between birth weight, early childhood acute respiratory infections and exposures to (indoor and outdoor) air pollution in a rural-urban mother-child (M-C) cohort in Tamil Nadu. 2-Establishing relationships between respiratory symptoms, pulmonary function and exposures to (indoor and outdoor) air pollution in a rural-urban adult cohort in Tamil Nadu 3-Quantifying exposures and establishing relationships between indoor, outdoor,	The exposure-response relationships established through the TAPHE studies are unique in many respects in contributing to the global pool of evidence as listed below:- 1-By performing more than 4000 measurements of household area concentrations across rural and urban households, ambient measurements across 82 (rural and urban) locations and time-activity assessments on nearly 2400 subjects , the study was able to generate 24-hr $PM_{2.5}$ exposure estimates for both rural and urban populations. The detailed measures served to considerably reduce exposure misclassification in the models developed	Policy brief available on icmrwebsite :www.icmr.nic.in

	and ambient concentrations and personal exposures for particulate matter and select air toxics for rural and urban households in Tamil Nadu. 4-Developing exposure models (including land–use regression models) to estimate long term exposures for rural and urban households in Tamil Nadu, India. 5-Establishing a bio-repository and developing protocols for examining gene-environment interactions in relation to air pollution and birth weight in a rural-urban cohort in Tamil Nadu, India.	to examine the exposure-response relationships within the TAPHE cohorts. 2-Among pregnant women, a 10µg/m^3 change in household $PM_{2.5}$ concentrations was associated with a 4 gm (95% CI -7.18, -1.38) decrease in birth weight or a 2% increase in low birth weight (OR =1.02; 95% CI, 1.003-1.037) after adjustment for cohort location (rural vs. urban), house construction (an SES indicator), SES, family size, primary cookfuel, location of kitchen, maternal education, occupation, age and BMI, sex of the child, maturity(term vs. pre-term), birth order(gravida) and previous history of a low birth weight child. Restricting the analyses to term births reduced the effects estimates slightly. 3-Among children linear regression models estimated a 0.3% increase in the longitudinal prevalence of ARI per 10 µg/m^3 change in household $PM_{2.5}$ concentrations, while Poisson regression models for episodes estimated a 0.09% increase in the number of episodes of ARI per 10 µg/m^3 change in household $PM_{2.5}$ concentrations after adjustment for malnutrition (weight-for-age z-score < -2), low birth weight, lack of exclusive breastfeeding during first 4 months, lack of measles immunization, solid fuel use, crowding, parental smoking, maternal illiteracy, season and birth order. 4-Among adults a 10µg/m^3 change in $PM_{2.5}$ concentrations was significantly associated with a 10% (OR=1.10; 95% CI 1.048, 1.153) increase in prevalence of respiratory symptoms, a lower FVC [17ml (95% CI-28ml, 5.9ml)] and a lower FEV1[15ml (95% CI-24ml, 4.9ml)]. Models were adjusted for gender, age, BMI, literacy	

		status and cohort location (rural vs. urban).	
9. Indoor Air Pollution and Asthma in Children : A population based study.	1-Quantification of the exposure to indoor air pollutants from solid fuel combustion. 2-Assessment of Exacerbation of Asthma /Emergency Department visit (ED visit)/quality of life and other asthma related variables in the exposed population and their association with the pollutants exposure. 3-Assessment of potential role of biomarkers and gene environment interaction. 4-Determination of effective interventional approach to see if effective intervention for reduction of exposure level is associated with reduction in asthma morbidity/Exacerbation/Emergency Department Visit.	Not available	Project was completed in the month of May 2018 and final report is awaited.
10. Study of microbial pollutants adsorbed on PM10 in urban ambient air to identify new risk factors for respiratory health.	1 Environmental Load Assessment of PM10 in high density traffic areas of Lucknow. 2 Microbiological analysis of sputum/ nasal swab/throat swab of study subjects. 3 Characterize new emerging risk factors for respiratory health with association of microbial pollutants adsorbed on PM10 in urban ambient air.	The average concentration of PM10 level in commercial and residential areas was continuously escalating every year during the study period from 2009-2012. The average bacterial count (CFU/m3) increased by 5% in 2010 but a quantum rise of 200% in the year 2011-2012 in commercial areas. Four species of bacteria are commonly found on PM10 and the throat & nasal swab samples of the exposed subjects are *Bacillus subtilis, Staphylococcus aureus, Staphylococcus epidermidis and Streptococcus pyogenes*. The change in the levels of lipid profile shows an abnormal profile but variations in the levels of the studied parameters were non-significant. The counts of monocytes, lymphocytes, neutrophils, and eosinophil were found to be increased in the	Final report available on(icmr website :www.icmr.nic.in) http://finalreport.icmr.org.in /finalreport/ Publications: 1. *Assessment of fungal contamination present on RSPM/PM10 and its association with human health*. **Rita Singh1**, Sushil Kumar2, Mastan Singh1*, Rajiv Garg3, SM Natu4, K P Singh1, RAS Kushwaha3, Mukesh

		exposed subjects & the changes were statistically significant ($p<0.05$). Platelet counts were not influenced. Erythrocyte sedimentation rate (ESR) increased more than 1fold and the change was highly significant ($p<0.001$). The analysis of questionnaire shows 62% of the exposed subjects are suffering from breathlessness, 46% from cough with expectoration, 41% from chest pain and 45% from irritation in respiratory tract as compared to control group (only 5% were suffered from breathlessness, 7% from cough with expectoration, 4% from chest pain and 26% from irritation in respiratory tract). The differences in all lung function parameters (FVC, FEV1, PEF) between the exposed and unexposed are statistically significant ($p<0.05$).	Verma2.***Biomedical Research 2013; 24 (4): 476-478.*** ***2.*** *"Health Effects of Vehicular Exhaust on Human Health"*. **Rita Singh**1, Mastan Singh1*, Rajiv Garg2, Sushil Kumar3, SM Natu4, K P Singh1, RAS Kushwaha2, Mohd Yusuf4, Mukesh Verma3.***Journal of Recent Advances in Applied Sciences (JRAAS) 29:82-86, 2014.*** ***3.*** *Rising ambient air pollution and risk of respiratory impairment in traffic policemen.* Rita Singh1*, Rajiv Garg2, Mastan Singh1, Jitendra K Chaudhary3.***Int J Pharm Bio Sci 2014 Oct; 5(4): (B) 293 – 298.***
II) NIOH			
1. A study of Indoor Air Quality	To assess the air quality of indoor environment of the houses of low socio-economic group using various types of fuels like cattle dung, wood, coal, kerosene, LPG etc.	• Levels of CO and HCHO were much higher (≥ 22 times) than occupational standards in the indoor air of the houses using traditional fuel. Levels of PAH were much higher (≥ 25 times) in these houses than outdoor levels. • Usage of coal gave rise to nearly 2 to 4 times in levels of PAH than the outdoor air. • Usage of kerosene did not significantly increase	NIOH, Ahemadabad Annual Report 1986-87 p. 11-20. **Publication** • Characterization and Problems of Indoor Pollution due to

		the levels of PAH except that of some low molecular wt. PAH. • Usage of LPG does did not contribute to any PAH to the considerable levels.	Cooking Stove SmokeC.V. Raiyani, S.H.Shah, N.M. Desai, K.Venkaiah, J.S. Patel, D.J. Parikh and S.K. Kashyap.Atmospheric Environemt Vol. 27A. No. 11, pp 1643-1655. 1993.(IF 2.81) • Assessment of Indoor Exposure to Polycyclic Hydrocarbons for the urban poors using various types of cooking fuels.Raiyani C.V., Jani J.P., Desai .N.M., Shah P.G., Shah S.H., and Kashyap S.K. Bull. Environ. Contam. Toxicol. 50, 757-763, 1993. • Mutagenic response of smoke particulates of bio-mass energy fuels. V.N. Gokani, P.B. Doctor, C.V. Raiyani, P.K. Kulkarni, N.M. Desai and S.K. Kashyap. Indian J. Occup. Environ. Med 1 (1997) 68. • A study on Indoor Air Pollutants: Toxicity Screening of Suspended Particulate

			Matter S.K.Gosh, T.S.Patel,P,B.Doctor, S.H.Shah, N.M.Desai and A.Y.Derasari. Bulletin of Env.Cont.& Toxicology.Vol.67,(no-1) 149-154, July 2001
2. Study of Air Pollution due to Vehicular Traffic in the major Cities/Towns of the Gujarat State.	• The Hon'ble High Court requested GPCB and NIOH to carry out traffic related air pollution monitoring for fourteen cities/towns of Gujarat state (Table-1) and to assess the effects on school children residing in various cities like Ahmedabad, Vadodara, Surat, Rajkot, Jamnagar and Bhavnagar	**Air Pollution Study** • The traffic related air pollution problems were serious particularly at traffic junctions in the cities like Ahmedabad, Vadodara, Surat and Bhavnagar. It is likely that there could be several other traffic junctions in these cities having similar or even higher levels of traffic related air pollution problems. • The air pollution levels were directly related to the number of vehicles in the city i.e. highest in Ahmedabad and the least in towns like Mithapur. • RPM, Co and occasionally NOx observed frequently violating the air quality levels Mithapur, Jamnagar and Rajkot were observed to be comparatively least affected by the traffic related air pollution problems • The air quality at Vapiwas deteriorated dominantly by the industrial activities compared to traffic, except at highway possibly due to highway traffic. **Health Study** • Symptoms such as cough, cough with expectoration and feeling of tightness of chest	A report of "Study of Air Pollution due to Vehicular Traffic in the major Cities/Towns of the Gujarat State." **Publication** Sinha, S.N., Patel, T.S., Shah, S.H., Desai, N.M. Patel, G.M., Mansuri, M.M. and Saiyed, H.N: A correlation of secondary aerosol (nitrate and sulfate) with respirable particulate matter (RPM) in ambient air at different traffic junction of Vadodara city. Journal of Environmental Biology, 26 (2), 187-190 (2005).

		which can be attributed to air pollution were present in 6(19.98%) out of 30 Children studied. • Chronic illnesses, which can be due to air pollution i.e. recurrent respiratory tract infection, were present in 2 out of 30 children (6.66%). • There was no statistically significant difference between the mean values of lead in blood of children of six cities. Out of 30 children 7 (21%) were having blood lead levels more than 10 µg/dl. In Jamnagar. 3 out of 5 children were having lead levels more than 10 µg/dl.	
3. Health Risk Assessment of Rural Population due to Indoor air pollution – Ahmedabad Study	• To develop a database on exposure level of benzene, toluene and xylene in indoor air. • To determine the pattern of morbidity due to indoor air pollution. • To assess the levels of relevant metabolites in the biological fluids as a marker of exposure.	**1. ENVIRONMENTAL MONITORING** • The concentrations of benzene, toluene and m-xylene found among petrol filler cum air filler & air filler category alone were lowest among all other categories viz, Manager > cashier > petrol filler in non-smoker and smoker categories respectively. • The levels of benzene among smokers and non-smokers were almost equal among the Gasoline filling Station workers. • The petrol filler category those were mainly involved in filling the petrol are exposed to Benzene more than other job category co-workers. • The levels of VOC's viz., benzene, toluene and m-xylene ranged from 1.53-135.67 µg/m^3 among the traffic policemen. Amongst the shopkeeper, the levels were found to be in the range of 1.47-674.0 µg/m^3. • The toluene concentration measured among the firewood users were statistically significant ($p<0.01$) compared to other fuel users. The	Report of "Health Risk Assessment of Rural Population due to Indoor air pollution – Ahmedabad Study". Publications • Sinha, S.N., Kulkarni, P. K., Shah, S.H., Desai, N.M. Patel, G.M., Mansuri, M.M. and Saiyed, H.N: Environmental monitoring of toluene and Xylene from indoor air produces due to combustion of solid biomass fuels, Science of the Total Environment. 357 (2006) 280. • Sinha, S.N., Kulkarni,

		kerosene users were found to be exposed to higher concentration of xylene compared to the other fuel category users and it was statistically significant. ($p<0.01$). • The results showed that the benzene concentration among firewood users in Hosakote village was statistically significant ($p< 0.01$) when compared to users in Chennamanahalli village. • The comparison was made between the urban and rural firewood users demonstrated that the concentrations of VOC's were higher in the urban users than the rural users **2. BIO- MONITORING** • The large variation (1.9-445.5 and 1.2- 487.7 $\mu g/m^3$) observed amongsmokers and non-smoker categories respectively in the gasoline filling stationwas mainly due to the quantity of gasoline and lubricants sold and the jobcategory (air fillers, cashiers, managers and petrol fillers). • The mean end shift urinary t,t-MA concentrations among smokers haveexceeded the ACGIH BEI value of 500 µg/g of creatinine. • The total group results revealed that the mean concentration of t,t-MA waswithin the prescribed limit. • The urinary t,t-MA levels among petrol fillers category had exceeded theACGIH BEI value of 500 µg/g of creatinine both in smoker and non-smokercategories. • The t,t-MA values among 15(57.7 %) traffic policemen who were smokers exceeded the ACGIH BEI value of 500 µg/gm of creatinine. • The non-smoking traffic policemen also had the urinary t,t-MA levelsexceeding (27.3%) the	P. K., Shah, S.H., Desai, N.M. Patel, G.M., Mansuri, M.M. and Saiyed, H.N., Gas chromatographic-mass spectroscopic determination of benzene in indoor air during the use of biomass fuels in cooking time. J. Chromatography A. 1065 (2005) 315-319.

		normal values may be attributed to the long term exposure to lower concentrations of benzene. **3. MORBIDITY STUDY** • The morbidity component of the study has tried to identify most common morbidity conditions prevalent among the study population of two villages at a particular point of time. • Because of the smaller sample size, the statistical inferences could not be drawn for the said conditions. Hence the study data can be considered as the baseline record for future prospective studies in this population. **3a** GASOLINE FILLING STATION WORKERS • The morbidity study of the Gasoline Filling Station Workers was carried out on 333 subjects • 74.7% of the workforce were within the age group of 35 years, 92% of the workers were either illiterate or matriculate • 78.4% of the workers were non-smokers, 91.8% were non-chewers of tobacco and 79.7% were non-alcoholics. • The most common morbidity conditions identified among this group were eye problems (11.7%), followed by headache (11.4%) and skin problems (2.4%). • It was observed that family history and personal history of hypertension contributed to 1.5% in each case whereas the family history of diabetes contributed to 7.5% of the personnel screened. • 1.8% had diabetes followed by hypertension contributed to 1.5%. very meager percentage of	

		mixed problems was reported among the study population (0.6%) followed by 0.3% stroke and 0.3% asthma **3 b. TRAFFIC POLICEMEN** • The morbidity study of the Traffic policemen was carried out on 227 subjects. • The Pulmonary Function Tests carried out among the group have identified 5.4% with severe, 26.2% with mild and 18.5% with moderate restrictive pulmonary function findings • It has revealed that 19.4% of the subjects were in the age group ≤30 years, 41% in the age group of 31-40 years. • The personal habits showed that 27.8% were smokers, 31.7% were alcoholics and very few i.e., 4.9% were chewers of tobacco. • 45.8% had the eye problems, 19.4% had headache and 18.1% had cough with or without expectoration 18.1% • 6.6% had the family history of hypertension and 8.4% had the family history of diabetes mellitus. • 4.9% had the personal history of hypertension and 6.6% had the history of diabetes mellitus.	
3. "National Environmental Health Profile & Comparative Health Risk Assessment" (NEHP & CHRA) Projects	• To document available environmental monitoring data for air, water and solid hazardous waste. • To collect information on actual human exposure for certain pollutants including lead and benzene. • To collect information of the community perception about environmental pollution and health risk.	• This study on "National Environmental Health Profile and Comparative Health Risk Assessment" conducted at Ahmedabad is sponsored by WHO and MoEF. The air pollutant levels at the residential, commercial and industrial areas were obtained from Gujarat Pollution Control Board. • The health examination was conducted in a total 679 families i.e. residential area (LD Engineering), 199 families commercial area	A report "National Environmental Health Profile &Comparative Health Risk Assessment" (NEHP & CHRA) Projects.

	• It is essential to obtain socio-economic information about the residentpopulation in different traffic zones of the city area. • Estimate of total burden of disease.	(Ashram Road) and 243 families of industrial area (Naroda). Both male and female residents in the age ranging from 6 to above 60 yrs. and a small number of children below 5 yrs constituted this study. Their personal history, ventilation in the house, hygienic condition in the house including quality and source of water consumed and no. of subjects in each family were noted. Recording of symptoms in coded proforma and measurement of lung function test were carried out among these residents. Statistical analysis was done using summary statistics, ANOVA, and Chi-square test. • Morbidity and mortality data from different hospitals located in Municipal Corporation of Ahmedabad and other sources were obtained. • The results revealed that pollutant levels were higher in Naroda i.e. industrial are compared to residential and commercial area. At all the places the SPM level was elevated compared to NAQS but not SO_2 and NO_2 levels. This elevation was more marked at Naroda area than other areas. • The morbidity and mortality data of Ahmedabad revealed higher morbidity from cardio respiratory diseases may be due to higher levels of SPM. • With regard to waterborne diseases gastroenteritis problems were high. However, the quality of water was in the prescribed limits. It may be that the higher prevalence of this disease due to heavy rains causing contamination of water, malfunction of pipes leading to leakage of contaminated water. • With regard to the prevalence of the diseases, Naroda area residents exhibited higher	

		prevalence than other areas. This is also evident from the lung function status as Naroda residents demonstrated significantly low lung function values. This may be due to combined effect of ambient air pollution and industrial pollution as some of the residents must be working in those nearby located industries.	
4. Exposure Assessment of 2,4 and 2,6-Toluene Diisocyanates (TDI) among flexible polyurethane foam industry workers	• Environmental and biological monitoring of Toluene Diisocynate in work place. • To assess the morbidity pattern among workers exposed to TDI • To study pulmonary function status of the exposed subjects; and • To suggest suitable control and intervention measures to reduce the exposure of isocyanates at workplaces.	• A total of 200 workers working in 7 flexible foam industries located in Gujarat and Silvasa were covered for the study. • The airborne Toluene Di-isocyanate (TDI) concentration found ranged from below detection limit of 0.68 ppb or 0.00068 ppm to 0.12 ppm. • From a total of 129 air samples from 7 flexible foam industries, 23 samples (17.83%) had exceeded the ACGIH TWA-TLV of 0.005 ppm mainly in foam production, block cutting and curing areas than other work areas. • Most of the workers were free from respiratory symptoms and this might be attributed to migration of workers from foam industry to other industries. • The Spirometry revealed that 87.1% of the subjects were not having any pulmonary impairment while 19(9.8%) and 4(2.1%) had restrictive and obstructive type of pulmonary function impairment respectively.	**Publication** Exposure to Toluene-di-isocyanate and respoiratory effects in flexible polyurethane foam industries in India Dr.S.Raghavan, Dr.RR Tiwari, Pankaj Doctor, Dr. Rekhakashyap, MM Manusuri&ParveenMansuri Toxicology & Industrial Health TIH-17-0293(Review 2 version submitted on 6th July 2018)-Sage Publishers, IF:1.378
5. Cardiological and Neurological health effects among rayon-	To carried out measurement of airborne Carbon disulpide (CS_2) and Hydrogen sulphide (H_2S) in different work shifts at different process plants of rayon-viscose	• Only few values of CS_2 had exceeded the permissible exposure limit of 10 ppm at viscose, spinning and after-treatments sections at certain time intervals.	

viscose workers exposed to carbon disulphide	industry located in Gujarat.	• Management has been suggested to improve the ventilation motor capacity through local exhaust systems (LEVs) to reduce the exposures of CS_2 and H_2S at viscose, spinning and after treatment departments in our submitted report.	
6. Health hazards among sewage treatment plant workers	• To evaluate health hazards among sewage treatment workers exposed to toxic air pollutants and endotoxins. • To measure CO, H_2S and Methane at different process areas of 03 sewage plants locate in and around Ahmedabad city.	• The H_2S levels had exceeded the permissible exposure limit of 10 ppm at sewage inlet areas, digester/bioreactors and aerators areas in all the three sewage treatment plant areas. • There was a necessity to mitigate odor problems and reduce H_2S exposures at sewage treatment plants and surround areas using low cost air pollution control technologies and they would be suggested to the stakeholders in due course of time.	
7. Indoor air pollution from biomass combustion and health hazards among people residing in slum areas of Ahmedabad.	• To assess the indoor air quality by harmful chemicals and other components due to human activities such as cooking, cleaning and use of personal deodorants/sprays/scents etc. • Biomass combustion generates Polycyclic Aromatic Hydrocarbons which have carcinogenic property. Pyrene, a non carcinogenic content of all PAHs mixture gets predominantly metabolized to 1-Hydroxy Pyrene (1-HOP). In all PAHs metabolites, only 1-HOP and its conjugates are excreted mainly in urine and they have higher fluorescence intensity	• The results of the indoor monitoring showed the presence of 12 PAHs namely Naphthalene, Acenaphthalene, 1-Methylnapthalene, 2-Methylnapthalene, Fluorene, Acenaphthene, Fluoranthene, Pyrene, Benzo (a) anthracene, Benzo (a) pyrene, Dibenzo (a,h) and anthracene, which were reportedly hazardous for human health. The Maximum concentration (1296.9 µg/m3) was found of Napthalene and a minimum (45.43 µg/m3) for Anthracene. Pulmonary Function Test of subjects showed 10	

	and easy to detect.	restrictive, 5 obstructive and 3 combined types of impairment. Results from the urine sample analysis shown the presence of 1-HOP, a biomarker for PAH exposure.	
8. Air quality study using airborne hyper spectral remote sensing and ground data at Ahmedabad & Kota (ISRO-Space Research Programme-Govt. of India &NIOH Collaboration)	The status of the ambient air quality has been established through field monitoring data. at Kota Rajasthan and Ahmedabad Gujarat	• Results of air monitoring data shows that, the levels of SO_2, NO_X were observed lower according to NAAQS guidelines set by CPCB India. In both cities, the 24 hrs particulate matter (PM_{10}) concentration was observed too much higher than the guideline set (100µg/m^3-24 hrs). • The air samples collected were also analyzed for 17 toxic Polycyclic Aromatic Hydrocarbons (PAHs) at four selected locations in Kota and Ahmedabad mentioned above. Four PAH compounds found at DCM Complex &Kaithun Agriculture Research Form at Kota; Kalupur Railway Station &Ramol Police Station, ISRO-Bopal and 5 PAH compounds found at Pirana in Ahmedabad were categorized as probable human carcinogens. • Based on known impact of air pollution, mainly focused on respiratory, cardio-vascular, skin & eye problems, hospital admission (registers) data during the study period were collected. Among the all diseases, increase in the cases for hypertension was reported from both the cities. In case of cardio-vascular diseases an increase has been recorded on total number of OPD cases registered from both the cities.	

9. Health study of population on and around coalfield area of Northern Coalfields Limited including the possible impact of Mercury	• To assess the respiratory health, ventilatory function and blood mercury levels in the coal field workers and the residents living in the vicinity of coal mines. • The status of the ambient air quality has been established through field monitoring data. • The air monitoring was carried out at five mines namely Bina, Jhingurda, Nigahi, Jayant and Dudhichua Mines Project Three locations were selected within the study (mine) area and two locations at residential area of the each mine.	• Air monitoring data shows that Respirable Particulate matters (RPM) concentrations were observed higher than guideline (300 µg/m^3). • The common respiratory complaints observed among coal miner were cough in 26(4.7%) workers of which only 8 had productive cough. Breathlessness and hemoptysis were reported by only 13(2.3%) and 3(0.5%) coal miners respectively. 51.4% of miners, 56.1% of supervisory workers and 37.1% of residents were hypertensive. • A total of 554 miners, 301 supervisory workers and 320 residents performed the pulmonary function Test. • The results of pulmonary function shows that, the pulmonary function impairments was observed higher in miners than comparison of residential and supervisor subjects. Out of 554 miners 50(9%) were have restrictive type abnormality, 22 have obstructive type abnormality and 7miners have combined type abnormality.	
10. Effect of Indoor Air Pollution on Women and Children in India-INDO-US project.	• To determine the distribution pattern of consumption of cooking fuels (e.g., biomass, coal, kerosene, and liquefied petroleum gas – LPG) by urban slum dwellers in different parts of the country. • A suitable proportion of target slum population from the selected city will be statistically determined.	• Finding of study revealed that during the cooking hours the concentrations of all the pollutants increases. In comparison of LPG using houses, different size particulate matter concentration, particles, CO and CO2 were found higher in the houses using kerosene. • Medical examination revealed that maximum families using kerosene as cooking fuel found anaemic, suffering from tuberculosis, asthma, chronic bronchitis, recurrent cough and cold. The reproductive health history of primary cooks shows that maximum still birth, child death,	

	The selection will be based upon geographical location, number of slums and dwellers, consumption of type of cooking fuel used, characteristics of slum population etc. This will be done using district wise sample survey with guidance from national source books. • To characterize the exposures of women and children to fine and ultrafine (nanoparticle) particulate matter from domestic fuel combustion using the exposure metrics of mass, number, surface area concentration and to study the relationships among these metrics. • To evaluate the impact of nanoparticle exposures on respiratory health status using both traditional spirometric methods to evaluate lung function parameters (FEV1, FVC, and PEFR) and cytokine expression profiles in sputum samples as biological markers of response to these exposures using protein array technology.	abortion and child congenital defect were observed in the population residing in slum area located near industrial area. • Result of spirometry test shows that, out of 571 primary cooks, 31 had abnormal PFT. Restrictive type abnormality found in 26 primary cooks. While the obstructive type abnormalities found in 5 primary cooks, majority of subjects were kerosene user.	
III) COEH, MAMC			

1. Health Impact of Firecrakers Bursting during Dussehra and Diwali in Delhi	- To study the air pollution during Diwali period - To study the impact of air pollution on eye, ear and respiratory system	1. The respiratory system related symptoms and signs were not much different pre and post dusshera and during Diwali. Although there was some increase in cough and breathlessness. But this did not translate into any significant illness requiring immediate medical attention. 2. Other system related complaints were also not much different pre and post dusshera and during Diwali. 3. Most of the subjects in the areas surveyed felt that environment was noisy during the day of Diwali and felt uncomfortable and few of them were not able to concentrate post - diwali. 4. Although there were no significant complaints of difficult in hearing or need to speak louder or understand the conversation post - diwali. 5. There were excessive watering from eyes, redness and burning sensation post – diwali in some areas. 6. Few cases were observed of itching following firecrackers bursting but no significant skin spots or issues with the hair dryness or itching post - diwali. 7. Hospital data showed some increase in post dusshera hospital visit and admission in some hospitals but the number was not significant statistically when data available from all hospitals were analyzed in a group. 8. Diwali data also reveals similar findings with non – significant increase in admission related to respiratory and cardiac diseases and stroke. We need to have more data from hospitals as only few hospitals have provided the requisite information. However, air pollution was high during this period	

		throughout Delhi and hence increase in admissions partly may be related to it in few hospitals. The need to study for longer period the impact of fire cracker bursting for many years continuously can throw the correct picture. 9. There was evidence of increased values of barium and strontium in urine samples of many subjects. These are some of the metals used in fire cracker manufacturing. Increased levels in urine do reflect a probability of exposure. However, all other elements are not increased to substantiate the effect of bursting of fire crackers. It is also possible that the individuals were exposed due to bursting of fire crackers directly or indirectly in their locality. 10. Increased levels of some of these metals were also recorded in CPCB Ambient air quality data during Diwali. 11. Deterioration in air quality was observed during Diwali day whereas it improved post Diwali as per the ambient air quality data provided by the Central Pollution Control Board. 12. Concentration of most of the elements in PM2.5 were reportedly increased during the day of Diwali except Calcium as per the information provided by CPCB. 13. There was lot of media and newspaper information for public awareness on fire cracker contributing to air pollution. 14. The restriction in use of fire crackers due to Hon'ble Supreme Court ban on sale also led to less bursting this season in Delhi. 15. There was less worsening of ambient air quality this time in comparison to last year as is reflected in	

		CPCB data. 16. The period of Dussehra and Diwali came much earlier compared to last year and stubble burning was much later this time which probably resulted in less deterioration in air quality. 17. However, the study involving larger population in some more areas and collection of data from a large number of hospitals may provide more information to find the immediate impact on health due to bursting of fire crackers worsening the air quality. It is also essential to study this impact for few years continuously by keeping the same population cohort under observation to see long term impact. 18. Air quality did worsen during Diwali and symptoms of eye, increased coughing, relatively more hospital visits, increased noise levels and high metal levels in urine do reflect adverse impact of fire cracker bursting. However, it was statistically not significant.	
2. Health impact Assessment of Pollution During Diwali awarded by Delhi Pollution Control Board	Health impact assessment of hazards arising out of burning of firecrackers	1. Overall, the results of the studies show that the main risk for human health may arise from **chronic inhalation exposure** as evident from the findings that out of total 557 study subjects, maximum no of individuals were reported with prevalence of **Breathing Difficulty (28.2%), and 20.30 % with eye disorders, 19.90 % with wheeze, 18.90 % with chest pain, 16.20 % with frequent abdominal pain, and 15.10 % with skin problems, 14.40 % with diabetes, and 15.30 %, with tuberculosis and 6.30 % with heart diseases 17.60 % with diarrheal disorders respectively.**	

		2. Few numbers of Cough, chest pain, breathing difficulties and skin problems etc. were reported, could also occur in general population. This area is full of industry like handloom and cotton industry also beedi and tobacco related products are manufactured on large scales As such, the atmosphere round the year in this locality has dusty & smoke and pollutants and thus these diseases among the general public of this locality are not very uncommon. 3. **Setting of a coal base thermal power plant may further add to the risk of the existing health disorders. These factors should be looked upon while initiating the proposed power plant set up in the Solapur area.** Therefore, as mentioned above, in the opinion on the health part of this risk assessment, the prevalence of gastric and respiratory disorders, skin and eye diseases were in high rate. This is the major term in the indirect exposure and thus the real exposure may be much higher than expected.	
3. Human health risk assessment of NTPC Plant at Solapur, Mahrashtra	To Carry out health risk assessment at Solapur, Maharashtra to identify the existing hazards before set up of NTPC Plant and Potential hazards to flora and fauna.	The festivities associated with Diwali created levels of noise which were perceived to be high and uncomfortable by a high proportion of those interviewed. 2. A significant proportion of those interviewed reported hearing associated problems during Diwali. The reported prevalence of ringing sensation in ears and difficulty in hearing were the most frequently reported complaints. These are directly caused by high noise. 3. Increased frequency of headache and a raise in	

		blood pressure were other reported complaints. 4. Frequencies of minor burn injuries were reported in significant numbers. Nearly 8 per cent of those interviewed suffered burn injuries. In absolute terms, the numbers could run in to thousands as we only interviewed some 264 subjects where as number of people participating in Diwali festivities runs in to millions. This is an extremely alarming development. 5. Those interviewed also reported a rise in adverse skin reactions and allergies. This may be due to the chemicals used in cracker manufacture that are released during burning. 6. Conditions related to an effect on eyes were frequently reported with redness, swelling and watering from eyes, as the most important complaints. These are signs of irritation caused by smoke, particulate air pollution, and irritant gases like sulfur dioxide and ammonia resulting from cracker use and candle burning. Blurring of vision was also reported by significant number of respondents. **We do not know if it was transient or would last**. The number of subjects reporting this was almost fifty per cent which also created difficulty in their routine day to day activities. 7. Eye injuries were also observed in about 5 per cent study population. This is also an alarmingly high number. 8. As regards respiratory disorders and acute events, breathlessness (medically dyspnoea), cough, and wheezing were the most frequent complaints. Nearly 12 per cent of those interviewed	

		complained of dyspnoea on exertion. *This may be done to a raise in blood pressure. As 50 per cent population does not know about their blood pressure, the complex may be triggered by such rise in B.P.* 9. Hospital data indicated an excess of cerebro-vascular accidents on all three days during Diwali when the pollution levels rise exponentially. This is the most significant outcome of the study. A combination of factors are responsible. 10. Eye injuries requiring hospital admission were not reported in the week following Diwali. There were three injuries reported on Diwali day, and one in the week preceeding Diwali. 11. Skin burns were almost 10 fold higher during Diwali week compared to preceding week, and 4 fold higher compared to post Diwali week.	
4. The impact of air pollution on respiratory health during Diwali Festival in India	Aim of finding out the impact of air pollution during Diwali (in Sanjay Gandhi Institute of Chest Diseases, Bagalore where patients come from Karnataka, Andhra Pradesh and West Bengal)	The number of admissions post-Diwali were significantly more compared to pre-Diwali from both rural and urban locations ($p<0.001$). The mean duration of hospital stay was significantly less pre-Diwali (7.59±0.74 days) compared to post-Diwali (9.46±0.44 days). Post Diwali, significantly increased number of patients required ventilator support. The mean duration of hospital stay was 7.59±0.74 days pre, and 9.46±0.44 days post Diwali. This was found to be statistically significant ($p<0.05$). There was a significant difference in patients requiring ventilator support pre and post-Diwali ($p = 0.0043$). But, there was no significant difference in the use of antibiotics, oxygen or nebulization.	

5. Status of air pollution during festival of lights (Diwali) in Jhansi, Bundelkhand Region	Impact of bursting crackers and fireworks on the ambient air quality of Jhansi city during Diwali festival in Nov 2013.	On Diwali, the level of SO2, NO2 and RSPM and SPM values were found in commercial and residential area to be 32.12, 60.26, 387.37 and 723.24 µg/m3 and in residential area to be 28.30, 52.69, 312.51, 618.31 µg/m3 respectively, which were very high when compared with any normal day of commercial area (7.18, 21.08, 126 and 257.21 µg/m3 respectively) and in residential area (6.28, 17.10, 107 and 214.67 µg/m3 respectively). On Diwali and after Diwali, the values of SO2, NO2 within range but RSPM and SPM were found to be much higher than the standard value of NAAQS. Hence, in the present study, crackers and fireworks were found to be the chief sources of air pollution during the Diwali festival. Even though the impact of Diwali is short term, but the short term exposure of these pollutants above the standard values causes health complications	
IV) TERI			
1. Variations in air quality at filling stations, Delhi, India	- To determine the ambient air quality at petroleum- filling stations in Delhi in the dry and rainy season. The pollutants analysed were carbon monoxide, nitrogen dioxide, PM10, PM2.5, benzene, toluene and xylene.	-Most of the air pollutants at filling stations in Delhi occur in levels that far exceed from the Indian national ambient air quality standards. -Air pollutants exhibited seasonal trends with higher levels in the dry season as compared to those in the rainy season.	Meena Sehgal, R Suresh, Ved Prakash Sharma and Sumit Kumar Gautam; Variations in air quality at filling stations, Delhi, India; International Journal of Environmental Studies; 2011; http://dx.doi.org/10.1080/00207233.2012.620320

2. Public health and air pollution in Asia (PAPA): Coordinated studies at short-term exposure to air pollution and daily mortality in two Indian cities	-To give investigators' Reports describing the studies with their methods, findings and conclusions. -Critique discussing the strengths and limitations along with uncertainties and implications of the findings for public health and future research.	-The Indian studies highlight that regional differences in demographics (particularly, age structure and general health status of population) may affect health outcomes of interest. -Data limitations prevented a number of in-depth analyses standard in time- series studies like of specific causes of death. -The lack of data on air quality and mortality especially cause- specific mortality remains a major impediment to conduct such studies in developing Asia.	Public Health and Air Pollution in Asia (PAPA): Coordinated studies of short- term exposure to air pollution and daily mortality in two Indian cities; Research Report 157; Health Effects Institute (HEI), Boston, MA, 2011
3. Indoor air quality in the rural India	To assess the exposure of cooks in rural India to the indoor air pollution levels emitted from burning of different fuels i.e. cow dung, wood, liquefied petroleum gas (LPG) and propane natural gas (PNG) kerosene for cooking purposes.	-Cow dung is the most polluting fuel with maximum emissions of PM10, PM2.5, VOCs, CO, NO2 and benzene followed by wood and kerosene. -Kerosene emits highest amount of polyaromatic hydrocarbons. -LPG/PNG leads to reductions of pollutants due to better combustion process.	Sumit Kumar Gautam, R Suresh, Ved Prakash Sharma and Meena Sehgal; Indoor air quality in the rural India; Management of Environmental Quality: An International Journal; 2013; Vol 24; No. 2; pp 244- 255; DOI 10.1108/14777831311303119

4. Disease burden due to biomass cooking- fuel-related household air pollution among women in India	-To estimate the attributable cases (AC) for four major diseases/ conditions (i.e. chronic bronchitis, tuberculosis, cataract and stillbirths) associated with biomass cooking fuel use among adult Indian women.	-The population attributable fraction varied across conditions being maximum for chronic bronchitis in rural areas and least for cataract in older age and urban areas. -About half of the cases of chronic bronchitis and tuberculosis among adult Indian women are attributable to household air pollution due to biomass cooking fuel.	Meena Sehgal, Suliankatchi Abdulkader Rizwan and Anand Krishnan; Disease burden due to biomass cooking-fuel- related household air pollution among women in India; Global Health Action; 2014; 7: 25326; http://dx.doi.org/10.3402/gha.v7.25326
5. Assessment of outdoor workers' exposure to air pollution in Delhi (India)	- To determine the exposure of toll plaza workers to air pollution and its effect on lung function. -To identify measures to mitigate the risks.	- High level of air pollution at all locations with PM2.5values exceeding national permissible limit - Reduction in lung function indices was significant amongst non-smoking outdoor workers - Pollutant concentrations were highest at municipality toll plazas with minimum protective work area. - Installation of ventilation systems; better traffic management; increase in number of lanes are some of the mitigation measures	Meena Sehgal, R Suresh, Ved Prakash Sharma and Sumit Kumat Gautam; Assessment of outdoor workers' exposure to air pollution in Delhi (India); International Journal of Environmental Studies, 2014; http://dx.doi.org/10.1080/00207233.2014.965937

6. Indoor air quality of non-residential urban buildings in Delhi, India	- To characterize the indoor air quality (IAQ) of different office and academic buildings in Delhi to assess the health risk of young population. - PM2.5, CO2 and VOCs were measured in indoor environment during pre-monsoon season.	- The average concentration of CO2 in office buildings was found to be higher than the ASHRAE standard. - The higher concentration of PM2.5 could be attributed to ductless- air conditioning system coupled with poor air- circulation and active air-filtration. - The pollutants (CO2, PM2.5 and VOCs) concentration was significantly lower in the educational buildings.	Arindam Datta, R Suresh, Akansha Gupta, Damini Singh, Priyanka Kulshrestha; Indoor air quality of non- residential urban buildings in Delhi, India; International Journal of Sustainable Build Environment; 2017; http://dx.doi.org/10.1016/j.ijsbe.2017.07.005
IV) PGI Chandigarh			
1. Association of outdoor air pollution with chronic respiratory morbidity: cross sectional study in an industrial town of Punjab	To study • Health Endpoints – Cardio-respiratory morbidity • Exposure Measurements- TSP, Nox, Sox, CO, ozone, elemental analysis • Morbidity Measurement - Questionnaire, EKG, Spirometer	Chronic respiratory symptoms (OR=1.5; 95% 1.2-1.8; p<0.00), and spirometric ventilatory defect (OR = 2.4; 95% CI = 2.0, 2.9; p < 0.001 higher in Mandi Gobindgarh (Low AQ) & Morinda (Better AQ), Punjab.	Kumar R, Sharma M, Srivastva A, Thakur JS, Jindal SK, Parwana HK. Association of outdoor air pollution with chronic respiratory morbidity in an industrial town in northern India. Arch Environ Health. 2004 Sep;59(9):471-7.
2. Biomass fuel and risk of tuberculosis: a case-control study from	Cross-sectional study on biomass fuel and risk of tuberculosis.	Results – Risk of Pulmonary TB (OR 3.14, (95% CI 1.15 to 8.56, p=0.02) for biomass fuel in comparison with LPG. Conclusion: Cooking with biomass fuel increases the risk for pulmonary tuberculosis.	Lakshmi PV, Virdi NK, Thakur JS, Smith KR, Bates MN, Kumar R. Biomass fuel and risk of tuberculosis: a case-control study from

Chandigarh UT			Northern India. J Epidemiol Community Health. 2012 May;66(5):457-61.
3. Household air pollution and stillbirths in India: analysis of the DLHS-II national survey	To study all stillbirths occurred among 188,917 women, National sampling	• women who cook with firewood (PR 1.24; 95% CI: 1.08-1.41, p=0.003) or kerosene (PR 1.36; 95% CI: 1.10-1.67, p=0.004) were more likely to have experienced a stillbirth than those who cook with LPG/electricity. • Conclusion: About 12% of stillbirths in India could be prevented by providing access to cleaner cooking fuel.	Lakshmi PV, Virdi NK, Sharma A, Tripathy JP, Smith KR, Bates MN, Kumar R. Household air pollution and stillbirths in India: analysis of the DLHS-II National Survey. Environ Res. 2013 Feb;121:17-22.
4. Respiratory symptoms in Indian women using domestic cooking fuels(biomass, LPG, kerosene and mixed fuels)	The effect of domestic cooking fuels producing various respiratory symptoms was studied in women.	• Of the 3701 women studied 3608 were non smoking women • The overall respiratory symptoms were observed in 13% patients. Mixed fuel users experienced more respiratory symptoms (16.7%) followed by biomass (12.6%), stove (11.4% and LPG (9.9%). • Chronic bronchitis in chulla users was significantly higher than that in kerosene and LPG users ($p<0.05$) • Dyspnoea and post nasal drip were significantly higher in women using mixed fuels • Smoking women who are also exposed to cooking fuels experienced respiratory symptoms more often than non smokers (33.3% vs 13%)	Diganbar Behera, Surinder Kumar Jindal. Respiratory symptoms in Indian women using domestic cooking fuel, Chest 1991; 100:385-88
5. Domestic fuel combustion and morbidity from asthama among non-smoking	To study Domestic fuel consumption and morbidity from asthama among non-smoking women	• Use of biomass was significantly more common among asthamatic women than controls (25% vs 4.0%) • Theree was no significant increase in any of the indices of morbidity from asthama among	Gupta D, Aggarwal AN, Chaudhary J, Jindal SK, Lung India (1999), XVII, No. 1 (P10-14)

women		patients using either kind of fuel • Patients using biomass fuels and having smokier kitchens had a greater number of emergency room visits and days off work per patient than patients using similar fuels but having relatively less smoky kitchens ($p<0.05$) • Conclusion: indoor air pollution form biomass fuel combustion does not cause increased morbidity among non smoking women with asthama, except probably where the exposure is heavier and persistent	
6. Prevalence and risk factors for bronchial asthma in Indian adults: a multi centric study	To estimate prevelance of bronchial asthama in differenet regions of India and to define risk factors influencing disease prevelance	• One or more respiratory symptoms was present in 4.3 – 10.5% subjects • Asthama was diagnosed in 2.28%, 1.69%, 2.05% and 2.38%. • Female esx, advancing age, usual residence in urban area, low socio-economic status, history suggestive of atopy, history of asthama in first degree relative, and all forms of tobacco smoking were associated with significantly higher odds of having asthma	For Asthma Epidemiology Study Group
7. Indian Study on Epidemiology of asthama, respiratory symptoms and chronic bronchitis	To detemine nationwide polpulation prevelance of and risk factors for asthamaand Chronic Bronchitis (CB) in adults	• One or more respiratory symptoms were present in 8.5% of individuals • The overall prevelance of asthma and CB was respectively 2.05% (adult aged ≥ 15 years) and 3.49% (adult aged ≥ 35 years) • Advancing age, smoking, household environmental tobacco smoke exposure, asthama in first degree relatibve and **use of unclean cooking fuels were associated with increased odds of asthama and CB**	SK Jundak, AN Aggarwal, D Gupta, R Agarwal, R Kumar, T Kaur, K Chaudhary, B Shah, Indian Journal of Tuberculosis Lung Disease 16(9):1270-1277
8. Health related quality of life in women exposed to wood smoke	Evatuate the effect of exposure to smoke from wood combustion while cooking on health related quality of life (HRQL) in 85 women using wood and 85 women using	• **WHOQOL-Bref transformed scores in psycological social relationships and environment domains were significantly lower in women using wood** than in women	AN Aggarwal, K Umasankar, D Gupta, Indian Journal of Tuberculosis Lung

while cooking	LPG using abbreviated WHO quality of Life (WHO QOL) questionnaire	using LPG	Disease 18 (8); 992-994
V) VP Chest Institute, Delhi			
1. Association of Indoor and Outdoor Air Pollutant Level With Respiratory Problems Among Children in an Industrial Area of Delhi, India	To assess the association between outdoor and indoor air pollutants with respiratory problems in children (aged 7–15 years), who live near an industrial area located in Delhi, India.	• Majority of children had a history of respiratory problems, including cough (62.7%), sputum production (24.4%), shortness of breath (32.0%), wheezing (25.6%), common cold (44.4%), and throat congestion (43.1%). • The association of indoor and outdoor air pollutant levels showed that outdoor SO2 and NO2 was significantly higher than indoor SO2 and NO2 levels, whereas the mean indoor level of suspended particulate matter (SPM) was significantly higher than outdoor SPM level. • **Indoor SPM level also was significantly higher in homes of children with a history of respiratory illness than homes of children having no history of respiratory illness.** • Results suggest that both indoor and outdoor particulate exposure may be important risk factors in the development of respiratory illness in children.	Raj Kumar, MD; Jitendra K. Et al, Association of Indoor and Outdoor Air Pollutant Level With Respiratory Problems Among Children in an Industrial Area of Delhi, India, Archives of Environment & occupational health, Vol 62 No, 2007
2. Impact of Domestic Air Pollution from Cooking Fuel on Respiratory Allergies in Children in India	To identify the effects of cooking fuels (such as LP gas and biomass) and indoor air pollutants on asthma, rhinitis and upper respiratory tract infection (URTI) allergies in children residing in Delhi, India.	• 31.2% of the children's families were using biomass fuels for cooking and 68.8% were using liquefied petroleum gas. • Levels of indoor SO2, NO2 and SPM, measured using a Handy Air Sampler (Low Volume Sampler), were 4.60 ± 5.66 µg/m3, 30.70 ± 23.95 µg/m3 and 705 ± 441.6 µg/m3, respectively. • The mean level of indoor SO2 was significantly higher (p = 0.016) for families using biomass fuels (coal, wood, cow dung cakes and	Raj Kumar, Jitendra K. Nagar et al, Impact of Domestic Air Pollution from Cooking Fuel on Respiratory Allergies in Children in India, Asia Pacific Journal of Allergy & immunology (2008) 26; 213-222

		kerosene) for cooking as compared to families using LP gas. • The mean level of indoor NO_2 for families using biomass fuels for cooking was significantly higher in I.T.O. ($p = 0.003$) and Janakpuri ($p = 0.007$), while indoor SPM was significantly higher in Ashok Vihar ($p = 0.039$) and I.T.O. ($p = 0.001$), when compared to families using LP gas. • Significantly higher numbers of asthmatic children in I.T.O. ($p = 0.016$), Janakpuri ($p = 0.038$) and Nizamuddin ($p = 0.004$) were found in families who generally used biomass fuels (coal, wood, kerosene and cow dung) for cooking compared to families using LP gas fuel for cooking. Asthma in children was significantly ($p = 0.016$) greater in Shahzada Bag where families were using LP gas fuels for cooking compared to families using biomass fuels for cooking. Rhinitis in the children was significantly more frequent in Nizamuddin ($p = 0.027$) and Dallupura ($p = 0.009$) where families were using biomass fuels for cooking compared to families using LP gas fuel for cooking. Rhinitis in the children was also significantly higher in the Siri Fort ($p = 0.004$) and Shahzada Bag ($p = 0.027$) where families were using LP gas fuels for cooking compared to families using biomass fuels for cooking. Upper respiratory tract infection (URTI) in children was associated with both types of cooking fuels • **This study suggests that biomass fuels increased the concentrations of indoor air pollutants that cause asthma, rhinitis and URTI in children. LP gas smoke was also**	

		• The study impresses upon the role of ICS usage in reducing toxic substances that impair the NMC, a respiratory health indicator. • It also highlights the need for spreading awareness towards cooking smoke exposures and the advantage of using ICS.	
5. Indoor Air Pollution and Respiratory Illness in Children from Rural India: A Pilot Study	Indoor air pollution measured in terms of particulate matter <2.5μm in diameter (PM2.5), is an important cause of respiratory illness in children. Therefore, PM2.5 levels in rural households and its correlation with respiratory illness-related symptoms in children were studied.	• The average minimum and maximum PM2.5 levels were 1.10mg/m3 and 18.17mg/m3, respectively (mean=4.99mg/m3) in the 17 control households. • The PM2.5 levels were significantly greater ($p<0.05$) in houses where children had respiratory symptoms compared to the control households. • Biomass fuel use and number of family members were significantly associated with respiratory illness in children.	Indoor Air Pollution and Respiratory Illness in Children from Rural India: A Pilot Study, Raj Kumar1, Nitin Goel1, Indian Journal of Chest Disease and Allied Sciences
6. Indoor air pollution and asthma in children at Delhi, India	To study Indoor air pollution and asthma in children at Delhi, India	• 32.4% children were exposed to environmental tobacco smoke. 31.5 % children's families were using biomass fuels for cooking. History of respiratory symptoms included cough (43.9%), phlegm production (21.9%), shortness of breath (19.3%) and wheezing (14.0%). 7.9% children were diagnosed as having asthma, which was highest in industrial areas (11.8%), followed by residential (7.5%) and village areas (3.9%). • The mean indoor SO2, NO2 and SPM levels were 4.28±4.61 mg/m3, 26.70 ± 17.72 mg/m3 and 722.0 ± 457.6 mg/m3 respectively. Indoor SPM was the highest in industrial area followed by residential area and urban village area. Indoor SPM level was significantly ($p < 0.001$) higher in the asthmatic children's houses. • This study suggests that industry plays an important role in increasing the concentration of	Indoor air pollution and asthma in children at Delhi, India Raj Kumar, Jitendra K Nagar et al; Pneumonologia i Alergologia Polska 2015, vol. 83, no. 4

		• The study impresses upon the role of ICS usage in reducing toxic substances that impair the NMC, a respiratory health indicator. • It also highlights the need for spreading awareness towards cooking smoke exposures and the advantage of using ICS.	
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6. Indoor air pollution and asthma in children at Delhi, India	To study Indoor air pollution and asthma in children at Delhi, India	• 32.4% children were exposed to environmental tobacco smoke. 31.5 % children's families were using biomass fuels for cooking. History of respiratory symptoms included cough (43.9%), phlegm production (21.9%), shortness of breath (19.3%) and wheezing (14.0%). 7.9% children were diagnosed as having asthma, which was highest in industrial areas (11.8%), followed by residential (7.5%) and village areas (3.9%). • The mean indoor SO2, NO2 and SPM levels were 4.28±4.61 mg/m3, 26.70 ± 17.72 mg/m3 and 722.0 ± 457.6 mg/m3 respectively. Indoor SPM was the highest in industrial area followed by residential area and urban village area. Indoor SPM level was significantly ($p < 0.001$) higher in the asthmatic children's houses. • This study suggests that industry plays an important role in increasing the concentration of	Indoor air pollution and asthma in children at Delhi, India Raj Kumar, Jitendra K Nagar et al; Pneumonologia i Alergologia Polska 2015, vol. 83, no. 4

		indoor suspended particulate matter and occurrence of asthma in children in developing countries like India.	
7. Pollutant Levels at Cooking Place and Their Association with Respiratory Symptoms in Women in a Rural Area of Delhi-NCR	To compare respiratory symptoms in females in relation to cooking at two different locations (separate room and closed space), and their association with concentration of the PM (PM10, PM2.5 and PM1) and VOCs, in a rural area of the Delhi-National Capital Region (NCR).	• 46 households (Group A) women had a separate room as kitchen for cooking with good ventilation and exhaust conditions; and in the remaining 46 households (Group B) cooking was done in the living area. Seventy (76.1%) households used biomass fuel for cooking and heating (37; 80.4%, in Group A versus 46; 100% in Group B). • The proportion of women with respiratory symptoms for one year or more was significantly high in Group B compared to Group A (13.0% versus 3.1% p=0.01). • The households which did not have a separate kitchen (Group B) had higher particulate matter and VOCs concentration. • Conclusions. This study contributes to the growing evidence of adverse impact of indoor air pollution from biomass combustion on health of females. Results of the study demonstrated significantly high particulate matter (PM2.5), in households not using a separate room for cooking with biomass fuel.	Pollutant Levels at Cooking Place and Their Association with Respiratory Symptoms in Women in a Rural Area of Delhi-NCR; Raj Kumar, Kamal Singh et al;, Indian J Chest Dis Allied Sci 2015
VI) AIIMS Delhi			
1. Association of particulate matter exposure and depression: A Systematic Review and Meta-analysis		• Modest strength of association for $PM_{2.5}$ exposure and depression found	Harshal R Salve, Siva Santosh Kumar Pentapati, Rajesh Sagar, V Sreenivas Presented in Joint Annual Meeting of ISEE – ISEE,

			Ottawa, Canada – August, 2018 {PROSPERO (CRD42017075608)}
VII) IISc Bangalore			
2. Allergic disorders in the working environment of traffic and non-traffic police personnel	To find out the prevalence of allergic problems in particular asthma in 1040 traffic police personnel who inhale automobile exhaust over 8 hours and 1160 non traffic police personnel as controls	• Traffic police personnel suffer twice more than non traffic police personnel with asthma, chronic cough, breathlessness, rhinitis, wheeze, conjunctivitis and urticaria. • These symptoms are 50% less if they live over 20 kms from the centre of the city • On the contrary the non traffic personnel who live over 20 kms away from the city developed sensitivity to indoor aeroallegens predominantly fungal spores and show 11.53% skin test positivity than traffic police of 0.93%. • Outdoor and indoor air pollution are major contributing factors in increasing prevalence of asthma and allergy	National symposium on environment, June 2002

4. Conclusion

1. Studies showed that higher morbidity from cardio-respiratory diseases may be due to higher levels of Suspended Particulate Matter (SPM). The average concentration of PM10 level in commercial and residential areas was continuously increasing. Pulmonary Function test showed reduced capacities/ abnormalities associated with air pollution. Reduction in lung function indices was significant amongst non-smoking outdoor workers.

2. The traffic related air pollution problems in the cities were serious particularly at traffic junctions in the cities. The air pollution levels were directly related to the number of vehicles in the city.

3. Studies show there is greater risk of Pulmonary TB, respiratory symptoms, chronic bronchitis and asthma for biomass fuel users in comparison with LPG. About half of the cases of chronic bronchitis and tuberculosis among adult Indian women are attributable to household air pollution due to biomass cooking fuel.

4. During the cooking hours the concentrations of all the pollutants increases. In comparison to LPG using houses, particulate matter concentration, CO and CO2 were found higher in the houses using kerosene. Cow dung is the most polluting fuel with maximum emissions of PM10, PM2.5, VOCs, CO, NO2 and benzene followed by wood and kerosene. Levels of CO and HCHO were much higher than occupational standards in the indoor air of the houses using traditional fuel. Levels of PAH were much higher in these houses than outdoor levels.

5. Families using Kerosene as cooking fuel were found anaemic, suffering from tuberculosis, asthma, chronic bronchitis, recurrent cough and cold. The reproductive health history of primary cooks showed increase in still birth, child death, abortion and child congenital defect.

6. Among pregnant women, a 10µg/m3 change in household PM2.5 concentrations was associated with a 4 gm (95% CI -7.18, -1.38) decrease in birth weight or a 2% increase in low birth weight. Restricting the analyses to term births reduced the effects estimates slightly. About 12% of stillbirths in India could be prevented by providing access to cleaner cooking fuel.

7. Pre and post Dusshera and during Diwali comparison showed although there was some increase in cough and breathlessness but it did not translate into significant illness requiring immediate medical attention. There is increased reporting of eye and ear related morbidity like redness & irritation in eyes and hearing difficulty.During Dussehra/ Diwali in one setting hospital data showed some increase in post dusshera hospital visit and admission but the number was not significant statistically when data available from all hospitals were analyzed. Diwali data also revealed similar findings with non – significant increase in admission related to respiratory and cardiac diseases and stroke. The data was, however, not available from all hospitals. In another setting hospital data indicated an excess of cerebro-vascular accidents on all three days during Diwali when the pollution levels rise exponentially which may be due to a combination of reasons. Significant difference were also observed pre and post Diwali in Number

of admission, length of stay and number requiring ventilator support, however, use of antibiotics, oxygen and nebulization was not significantly different. The restriction in use of fire crackers due to Hon'ble Supreme Court ban on sale led to less bursting in the season in Delhi. There was less worsening of ambient air quality in comparison to last year as is reflected in CPCB data which may also be partly due to early Diwali when stubble burning had not started.

8. Health sector should advocate for controlling air pollution to combat epidemic of non-communicable diseases. High priority should be accorded to clean fuel for cooking and heating. Prevention and minimization of exposure during infancy may be accomplished by promoting maternal education and by improving socioeconomic development, all of which can lead to better nutritional and health status. Future strategies should include changes in cooking practices and childrearing habits. Furthermore, informing parents about symptoms that indicate the severity of illness and the importance of early treatment at a health center might be valuable in this context.

5. Action points for MoHFW

The main action points that emerged from the committee are as follows:

1. A high level Task Force on mitigating effects of Air Pollution on Human Health to be constituted, with participation of stakeholder ministries but under overall leadership of MoHFW to suggest remedial measures.

1. Advocacy and IEC to generate with public awareness to prevent pollution and hazards of air pollution need to be done through all states/ UTs government, private organizations, NGOs and media. Increased risk communication through public awareness campaigns will be helpful to sensitise people about adverse effects of air pollution, to take simple measures to prevent harmful health effects and utilize services available for illnesses.

2. Heath systems strengthening and Convergence of air pollution is needed at programmatic level with many national health programmes in particular for non-communicable diseases since air pollution is linked to increase in cancers, cardiovascular diseases and COPDs.

3. Preparedness of public health systems for air pollution emergencies needs to be ensured, especially management of increased episodic illnesses such as ARI, asthma, CVDs.

4. Training of health care staff, availability of appropriate equipment and drugs and functional cardiac units at district level are required.

5. National standards and acceptable limits of major hazardous air pollutants to be reviewed from human health perspective.

6. Further research on air pollution should be continued.

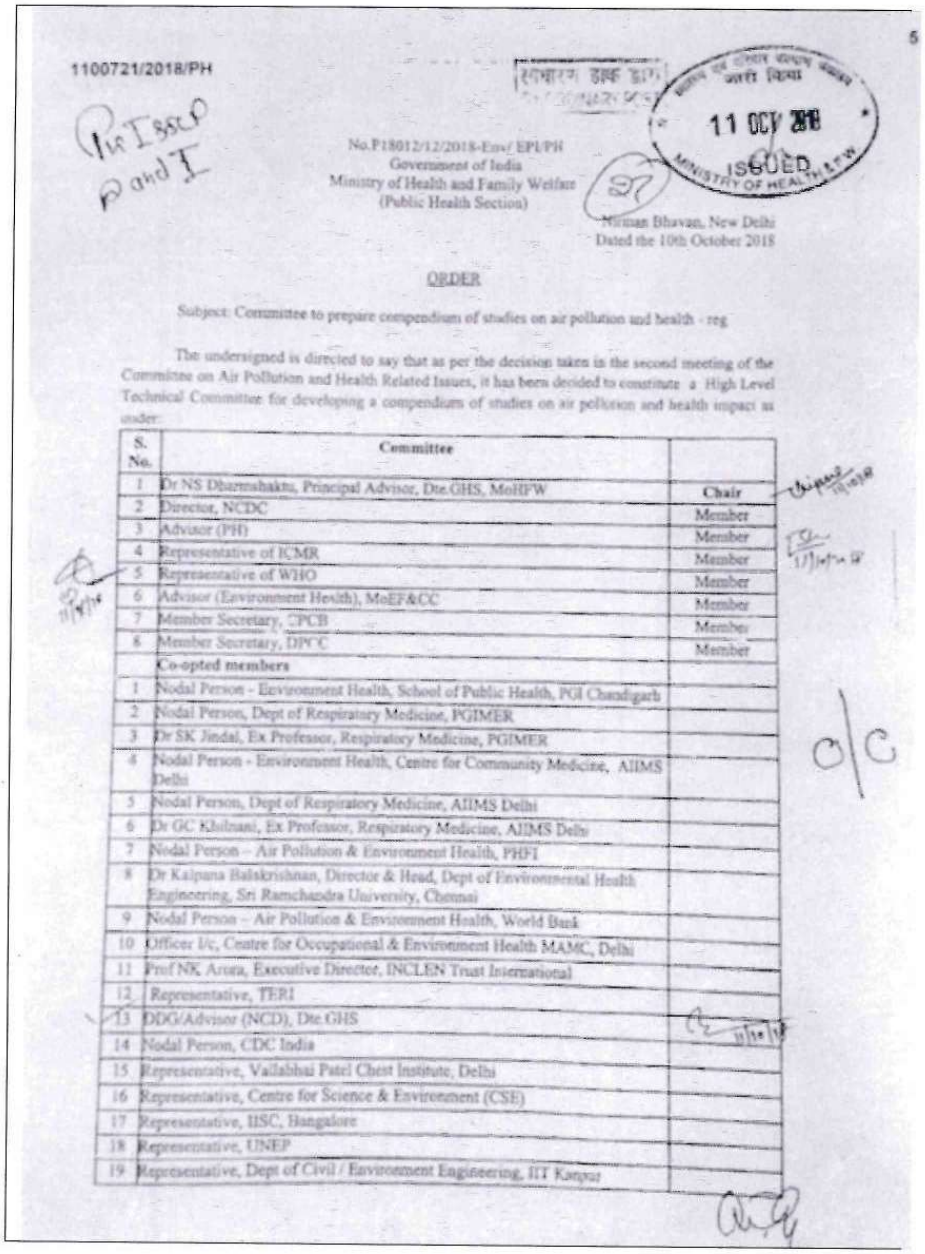
- Though, international estimates are available for health impact of air pollution but there is a need for better understanding of these estimates. More quality research is needed on in-country estimates. Large multi-centric prospective time series studies and cohort studies should be conducted to quantify health effects of air pollution using standard methodology.
- Country specific IER (Integrated Exposure Response) on air pollution are not available which affects the Indian estimates derived and limits the confidence in their usage by policy makers and decision takers. There is need for bridging country specific information gap on IERs for air pollution and health impact. Studies in this regard need to be taken up.
- Centres of Excellence (besides Sri Ramchandra University which is ICMR CARR) on estimating air pollution exposures to be set up in north India as well. The suggested institutes were IIT Kanpur and PGI Chandigarh.

7. Ministry of Environment, Forests and Climate Change, Ministry of Renewable Energy, Ministry of Petroleum and natural gas should organize seminar for developing public health specific schemes and programmes.
8. This Compendium on environment and health needs to be updated every three years in order to share findings with stakeholders and all the States/ UT Governments to develop in-country capacities in different areas.

1904275/2020/O/O NCDC

Appendix 1

Appendix 2



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No.P18012/12/2018-Env/ EPI/PH
Government of India
Ministry of Health and Family Welfare
(Public Health Section)

Nirman Bhavan, New Delhi
Dated the 10th October 2018

ORDER

Subject: Committee to prepare compendium of studies on air pollution and health - reg

The undersigned is directed to say that as per the decision taken in the second meeting of the Committee on Air Pollution and Health Related Issues, it has been decided to constitute a High Level Technical Committee for developing a compendium of studies on air pollution and health impact as under:

S. No.	Committee	
1	Dr NS Dharmshaktu, Principal Advisor, Dte.GHS, MoHFW	Chair
2	Director, NCDC	Member
3	Advisor (PH)	Member
4	Representative of ICMR	Member
5	Representative of WHO	Member
6	Advisor (Environment Health), MoEF&CC	Member
7	Member Secretary, CPCB	Member
8	Member Secretary, DPCC	Member
	Co-opted members	
1	Nodal Person - Environment Health, School of Public Health, PGI Chandigarh	
2	Nodal Person, Dept of Respiratory Medicine, PGIMER	
3	Dr SK Jindal, Ex Professor, Respiratory Medicine, PGIMER	
4	Nodal Person - Environment Health, Centre for Community Medicine, AIIMS Delhi	
5	Nodal Person, Dept of Respiratory Medicine, AIIMS Delhi	
6	Dr GC Khilnani, Ex Professor, Respiratory Medicine, AIIMS Delhi	
7	Nodal Person – Air Pollution & Environment Health, PHFI	
8	Dr Kalpana Balakrishnan, Director & Head, Dept of Environmental Health Engineering, Sri Ramchandra University, Chennai	
9	Nodal Person – Air Pollution & Environment Health, World Bank	
10	Officer I/c, Centre for Occupational & Environment Health MAMC, Delhi	
11	Prof NK Arora, Executive Director, INCLEN Trust International	
12	Representative, TERI	
13	DDG(Advisor (NCD), Dte.GHS	
14	Nodal Person, CDC India	
15	Representative, Vallabhai Patel Chest Institute, Delhi	
16	Representative, Centre for Science & Environment (CSE)	
17	Representative, IISC, Bangalore	
18	Representative, UNEP	
19	Representative, Dept of Civil / Environment Engineering, IIT Kanpur	