INDO-US COLLABORATION ON ENVIRONMENTAL AND OCCUPATIONAL HEALTH

PROCEEDINGS

Joint Workshop On Environmental Risks Of Respiratory Disease

Recommendations and Abstracts

September 5-6, 2008
Chandigarh, India

Under the auspices of

Indian Council of Medical Research

and

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
National Institutes of Health

NIEHS
National Institute of Environmental Health Sciences

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

Hosted by
Department of Pulmonary Medicine
Postgraduate Institute of Medical Education and Research, Chandigarh (India)

Chandigarh, March 2009

Proceedings compiled and edited by

Dr. S. K. Jindal and Dr. Navneet Singh

Department of Pulmonary Medicine,

Postgraduate Institute of Medical Education and Research, Chandigarh (India)

TABLE OF CONTENTS

PARTICIPANTS

Ritesh Agarwal
Assistant Professor, Department of Pulmonary Medicine,
Postgraduate Institute of Medical Education & Research (PGIMER),
Chandigarh, India
Email: riteshpgi@gmail.com

Ashutosh N. Aggarwal
Associate Professor, Department of Pulmonary Medicine,
Postgraduate Institute of Medical Education & Research (PGIMER),
Chandigarh, India
Email: ashutosh@indiachest.org

Veena Antony
Professor of Medicine, Molecular Genetics and Microbiology and
Division Chief, Pulmonary, Critical Care and Sleep Medicine,
University of Florida College of Medicine,
Orlando, USA
E-mail: veena.antony@medicine.ufl.edu

Kalpana Balakrishnan
Professor & Head, Department of Environmental Health Engineering,
Sri Ramachandra University,
Chennai, India
Email: kalpanasrmc@vsnl.com

Digambar Behera
Director,
LRS Institute of Tuberculosis & Allied Diseases,
New Delhi, India
Email: dbehera@glide.net.in

Homer A. Boushey
Professor, Pulmonary and Critical Care Division, Department of Medicine,
University of California School of Medicine,
San Francisco, USA
Email: homer.boushey@ucsf.edu

Nigel G. Bruce
Reader and Head, Division of Public Health,
University of Liverpool, UK
Email: ngb@liverpool.ac.uk

Dhruv Chaudhry
Professor, Department of Medicine,
Pt BD Sharma PGIMS,
Rohtak, India
Email: dhruvachaudhry@yahoo.co.in

S. K. Chhabra
Professor, Department of Cardiorespiratory Physiology,
Vallabhbhai Patel Chest Institute (VPCI),
New Delhi, India
Email: skchhabra@lycos.com

Rohini Chowgule
Managing Director, Chowgule Mediconsult Private Limited (CMPL) and
Executive Director, Indian Institute for Environmental Medicine,
Mumbai, India
Email: cmplbom@gmail.com, drrohini@vsnl.com

R. S. Dhaliwal
Assistant Director General (Non Communicable Diseases),
Indian Council of Medical Research,
New Delhi, India
Email: dhaliwalrs@icmr.org.in

Gregory B. Diette
Associate Professor of Medicine, Epidemiology and Environmental Health,
Johns Hopkins University, USA
Email: gdiette@jhmi.edu

N. K. Ganguly
Former Director General, Indian Council of Medical Research,
Advisor to the Minister of Health and Family Welfare, Government of India
Email: nkganguly@nii.res.in

C. S. Ghosh
Professor & Head, Department of Respiratory Medicine,
Medical College,
Thiruvananthapuram, India
Email: mctvm@md2.vsnl.net.in

Jeff Glassroth
Vice Dean and Chief Academic Officer
Professor of Medicine (Pulmonary and Critical Care)
Feinberg School of Medicine, Northwestern University
Chicago, USA
Email: j-glassroth@northwestern.edu

Randeep Guleria
Professor, Department of Medicine,
All India Institute of Medical Sciences (AIIMS),
New Delhi, India
Email: randeepg@hotmail.com

Dheeraj Gupta
Additional Professor, Department of Pulmonary Medicine,
Postgraduate Institute of Medical Education & Research (PGIMER),
Chandigarh, India
Email: dheeraj@indiachest.org

Patricia Hibberd
Director, Center for Global Health Research
Professor, Departments of Public Health and Family Medicine, Medicine and Pediatrics
Tufts University School of Medicine
Boston, USA
Email: patricia.hibberd@tufts.edu

Surinder K. Jindal
Professor & Head, Department of Pulmonary Medicine,
Postgraduate Institute of Medical Education & Research (PGIMER),
Chandigarh, India
Email: skjindal@indiachest.org

Tanvir Kaur
Assistant Director General (Non Communicable Diseases),
Indian Council of Medical Research,
New Delhi, India
Email: kaurt@icmr.org.in

Vikas Kapil
Chief, Surveillance and Registries Branch and
Coordinator, Indo-US collaboration in Environmental and Occupational Health,
Agency for Toxic Substances and Disease Registry,
Centers for Disease Control and Prevention,
Atlanta, USA
E-mail: vck3@cdc.gov, vikas.kapil@cdc.hhs.gov

Surender Kashyap
Principal,
Indira Gandhi Medical College Hospital,
Shimla, India
Email: surenderkashyap@hotmail.com

G. C. Khilnani
Professor, Department of Medicine,
All India Institute of Medical Sciences (AIIMS),
New Delhi, India
Email: gckhil@hotmail.com

Rajesh Kumar
Professor and Head, School of Public Health,
Postgraduate Institute of Medical Education & Research (PGIMER),
Chandigarh, India
Email: dr.rajeshkumar@gmail.com

James E. Lockey
Professor - Division of Occupational and Environmental Medicine, Department of Environmental Health and Pulmonary Division, Department of Internal Medicine
University of Cincinnati College of Medicine, USA
Email: james.lockey@uc.edu

George Luber
Associate Director for Global Climate Change,
National Center for Environmental Health,
Centers for Disease Control & Prevention,
Atlanta, USA
Email: gluber@cdc.gov

William J. Martin II
Associate Director, NIEHS
Director, Office of Translational Research
National Institute for Environmental Health Sciences (NIEHS),
Research Triangle Park, North Carolina, USA
E-mail: bill.martin@nih.hhs.gov, wm136j@nih.gov

Sumi Mehta
Senior Scientist,
Health Effects Institute,
Boston, USA
Email: smehta@healtheffects.org

P. K. Nag
Officer-incharge,
National Institute of Occupational Health,
Ahmedabad, India
Email: pranabnag@yahoo.com

Archana Patel
Professor and Head, Department of Pediatrics
Director, Clinical Epidemiology Unit
Indira Gandhi Government Medical College,
Nagpur, India
Email: dr_apatel@yahoo.com

Rajendra Prasad
Professor & Head, Department of Pulmonary Medicine,
CSM Medical University,
Lucknow, India
Email: rprasad2@rediffmail.com

Gregory Redding
Professor of Pediatrics, University of Washington School of Medicine
Chief, Pulmonary Division, Seattle Children's Hospital
Seattle, USA
Email: gredding@u.washington.edu, greg.redding@seattlechildrens.org

William N. Rom
Sol & Judith Bergstein Professor of Medicine and Environmental Medicine
Director, Division of Pulmonary and Critical Care Medicine
New York University School of Medicine
New York, USA
Email: william.rom@nyumc.org; william.rom@med.nyu.edu

Bela Shah
Senior Deputy Director General,
Head, Division of Non Communicable Diseases,
Indian Council of Medical Research,
New Delhi, India
Email: shahb@icmr.org.in

Daniel A. Singer
Associate Director, Global Health Research and International Activities,
National Institute of Child Health and Human Development (NICHD),
Washington D.C., USA
E-mail: singerda@mail.nih.gov

Meenu Singh
Additional Professor, Department of Pediatrics,
Postgraduate Institute of Medical Education & Research (PGIMER),
Chandigarh, India
Email: meenusingh4@rediffmail.com

Navneet Singh - *RAPPORTEUR*
Assistant Professor, Department of Pulmonary Medicine,
Postgraduate Institute of Medical Education & Research (PGIMER),
Chandigarh, India
Email: navneetchd@yahoo.com

Virendra Singh
Professor in Pulmonary Division, Department of Medicine,
SMS Medical College,
Jaipur, India
Email: drvirendrasingh@yahoo.com

Sunit Singhi
Professor & Head, Department of Pediatrics,
Postgraduate Institute of Medical Education & Research (PGIMER),
Chandigarh, India
Email: sunit.singhi@gmail.com

Kirk Smith
Professor of Global Environmental Health,
School of Public Health,
University of California,
Berkeley, USA
Email: krksmith@berkeley.edu

J. S. Thakur
Associate Professor, School of Public Health,
Postgraduate Institute of Medical Education & Research (PGIMER),
Chandigarh, India
Email: jsthakur64@gmail.com

Subhash Varma
Professor and Head, Department of Internal Medicine,
Postgraduate Institute of Medical Education & Research (PGIMER),
Chandigarh, India
Email: suvarma@yahoo.com, suvarma@hotmail.com

Indu Verma
Associate Professor, Department of Biochemistry,
Postgraduate Institute of Medical Education & Research (PGIMER),
Chandigarh, India
Email: induvermabio@rediffmail.com

Randy Wykoff
Dean, College of Public Health,
East Tennessee State University,
USA
Email: wykoff@mail.etsu.edu

SUPPORTING STAFF

Louise Williams
Centers for Disease Control & Prevention,
Atlanta, USA

Manju Aggarwal
Department of Pulmonary Medicine,
Postgraduate Institute of Medical Education & Research (PGIMER),
Chandigarh, India

JOINT INDO-US WORKSHOP ON ENVIRONMENTAL RISKS OF RESPIRATORY DISEASE

UT Guest House, Sector 6, Chandigarh, India
September 5-6, 2008

India Co-Chair: Surinder K. Jindal (PGIMER)
US Co-Chair: William J. Martin II (NIEHS, NIH)

DAY ONE – FRIDAY, SEPTEMBER 5, 2008

0830	**Registration**	
0900-0925	Welcome, Opening Remarks, Introductions, and Overview of Meeting	Surinder K. Jindal (PGIMER) K. K. Talwar (Director, PGIMER) William J. Martin II (NIEHS, NIH)
0925-0950	Indo-US Collaboration on Environmental and Occupational Health	R. S. Dhaliwal (ICMR) Vikas Kapil (CDC)

Session I	**Moderators: D. Behera and Daniel Singer**	
0950-1010	Healthcare and Role of Academic Health Centres in India	Subhash Varma (PGIMER)
1010-1050	Prevalence of Respiratory Disease in India	Dheeraj Gupta (PGIMER) Greg Diette (Johns Hopkins Univ)
1050-1100	**TEA BREAK**	
1100-1140	Environmental and Climate-Related Risks of Respiratory Disease	Kalpana Balakrishnan (SRMC) William Rom (New York Univ)
1140-1220	Challenges of Research in Rural India and the United States	Rajesh Kumar (PGIMER) R. Wykoff (E. Tennessee St. Univ)
1220-1245	Group Discussion	
1245-1345	**LUNCH**	

Session II	**Moderators: P. K. Nag and Daniel Singer**	
1345-1410	Respiratory and Health Effects of Indoor Air Pollution	Kirk Smith (Univ of California)
1410-1450	Respiratory and Health Effects of Outdoor Air Pollution	Sumi Mehta (HEI) S. K. Chhabra (VPCI, Delhi)
1450-1515	Impact of Tobacco Use on Respiratory Disease in India	Surinder K. Jindal (PGIMER)
1515-1530	Group Discussion	
1530-1545	**TEA BREAK**	
1545-1610	Occupational Respiratory Disease - Emerging Issues	J. Lockey (Univ of Cincinnati)
1615-1845	Field Visit to Rural Centre (Raipur Rani, Haryana)	

Evening Program (Venue: CII, Sector 31, Chandigarh)

1930-2000	Keynote Address: Environment, Industrialization and Respiratory Health in India	Nirmal K. Ganguly (MOHFW)
2000-2100	**DINNER**	

DAY TWO – SATURDAY, SEPTEMBER 6, 2008

Session I	**Moderators: Daniel Singer and C. S. Ghosh**	
0800-0810	Opening Remarks	Surinder K. Jindal (PGIMER) William J. Martin II (NIEHS, NIH)
0810-0850	Environmental Risks and Acute Respiratory Infection in Children in India	Archana Patel (IGGMC, Nagpur) Patricia Hibberd (Tufts Univ)
0850-0930	Environmental Risks of Tuberculosis	Virendra Singh (SMSMC, Jaipur) Jeff Glassroth (Northwestern Univ)
0930-1010	Early Life Environmental Exposures and i. Chronic Lung Disease in Children: Bronchitis and Bronchiectasis in Native Alaskans ii. Allergies and Asthma in Children in India	 G. Redding (Univ of Washington) Meenu Singh (PGIMER)
1010-1025	Group Discussion	
1025-1040	**TEA BREAK**	
1040-1105	Role of Environment and Respiratory Infections in Asthma	H. Boushey (Univ of California)
1105-1125	Climate Change and Health Impact, Including Allergies and Heat Related Illness	George Luber (CDC)
1125-1140	Knowledge Gaps and Research Priorities	J. S. Thakur (PGIMER)
1140-1200	ICMR Initiatives on Environmental Risks and Respiratory Diseases	Bela Shah (ICMR)
1205-1220	Group Discussion	
1220-1320	**LUNCH**	

Session II	**Working Groups**	
1320-1330	Remarks for Breakout of Working Groups	Bela Shah and Vikas Kapil
1330-1430	Group 1: Use of "Mini Sabbaticals" and Other Professional Development Opportunities for Mid-level and Senior Investigators	Facilitators: Veena Antony (Univ of Florida) Randeep Guleria (AIIMS)
	Group 2: Research and Educational Opportunities for Trainees (ITREOH, Fellowships, NIH RO1 Supplements, etc.)	Facilitators: Kirk Smith (Univ of California) D. Chaudhary (PGIMS, Rohtak)
1430-1515	Working Groups (1 & 2) Reports and Discussion	Bela Shah and Vikas Kapil
1515-1600	Group 3: Assessment of Research Priorities and Opportunities in Scientific Publication	Facilitators: William Rom (New York Univ) G. C. Khilnani (AIIMS)
1600-1645	Working Group (3) Report and Discussion	Bela Shah and Vikas Kapil
1645-1700	Closing Remarks and Next Steps	Surinder K. Jindal (PGIMER) William J. Martin II (NIEHS, NIH)

INDO-US COLLABORATION ON

ENVIRONMENTAL AND OCCUPATIONAL HEALTH

PROCEEDINGS

Joint Workshop On

Environmental Risks Of Respiratory Disease

A workshop on **Environmental Risks of Respiratory Disease** that involved participation of different health and environmental organizations from India and the United States of America (USA) was held on September 5-6, 2008 at Chandigarh, India. This was hosted by the department of Pulmonary Medicine, PGIMER, Chandigarh, India. The other partners for this joint Indo-US workshop were the Indian Council of Medical Research (ICMR), India; Centers for Disease Control and Prevention (CDC), USA; National Institute of Environmental Health Sciences (NIEHS), USA; the US Department of Health and Human Sciences and the National Institutes of Health (NIH), USA.

The workshop provided an opportunity for interaction between the Indian and the US investigators engaged in research in the field of respiratory sciences to develop common programmes and proposals related to research on different issues of environmental risks. The workshop was inaugurated by Director PGIMER, Prof K. K. Talwar and was attended by approximately 40 participants from different health care and environmental organizations from India and the USA.

RECOMMENDATIONS AND SUMMARY

Research Priorities in India: Indoor Air Pollution and Adult Health

Biomass exposure from wood, dung, and charcoal contributes to rural indoor air pollution in India with peak particles ranging from 10 to 1000 times PM standards during cooking episodes. These particles contribute to outdoor air pollution and global warming. 80% or more of rural households use biomass. Biomass contributes to 3.5% of morbidity/mortality and 400,000 deaths in children due to acute lower respiratory tract infections, COPD in women, and lung cancer primarily in women. Passive smoking exposure is another important cause of indoor air pollution in India.

Establish the Following Research Priorities

- Assemble research cohorts, e.g. community based health centers where populations can be better assessed for extent of biomass exposure. Questionnaires can be utilized to obtain information on health outcomes. Extrapolation can be used to decipher the extent of exposure and health problems utilizing key indicators of respiratory health, e.g. sickness days, cough and phlegm, dyspnea, wheeze, mortality.
- Assess exposure to biomass smoke. Further work needs to be done in measuring personal exposure to PM and CO as surrogates for wider exposures. Comparisons of PM need to be done for silica content, metal, fibers, and volatile organics.
- Encourage collaboration with U.S. investigators to better assess mechanisms. This could utilize blood sampling, sputum, bronchial or oral brushes to study for genomics or proteomics using automated platforms.
- Collaborations should also be pursued to assess imaging modalities and physiological testing.

- As adult disease is likely antecedent in childhood, the workgroup also supports the study of children exposed to IAP. Follow birth cohorts to assess perinatal exposure among neonates would be useful. Low birth weight relative to gestational age is an easily measured outcome and should be better evaluated.
- Different Interventions should be evaluated from the health perspective, including the introduction of clean fuels (e.g., liquid fuels such as LPG or ethanol for cooking) and cleaner stoves.
- Further and extended time-series studies correlating indoor air pollution (PM, SO_x, NO_x, Ozone) with mortality outcomes need to be encouraged.
- Development of collaborations to build research capacity through fellowships in research, MPH or MS graduate degree programs to develop faculty in India and to transfer technology.
- Longitudinal studies are necessary to study exposures over time and health outcomes. These would be advantageous to cross-sectional occupational health studies. U.S. collaborators could assist with study design issues.
- Focus on respiratory disease including COPD, asthma, pneumoconiosis and lung cancer. Novel mechanistic studies need to be considered. Additional areas include IAP and risk of cardiovascular disease and IAP and risk of infectious diseases such as pneumonias and tuberculosis.
- Monitor respiratory conditions, vector borne diseases, allergies and other conditions for changes in disease patterns related to climate change associated with IAP

Research Initiatives and Priorities for Indoor Air Pollution and Children's Health in India

The Pediatric Research Working Group identified several recommended areas of future focus related to the impact of environmental exposures on child health outcomes. Although there is some published information on the relative risks of respiratory symptoms and infections associated with biomass burning and passive tobacco smoke exposure, a number of key aspects that produce specific health outcomes remain to be better defined. Some of these include:

- Exposure-response relationship for each priority disease endpoint and combined effects of multiple components of incomplete combustion
- Contribution to total exposure of each component,
- Prenatal and postnatal exposure and impact on maternal and child health

The role of indoor and outdoor air pollution should be viewed as a combined exposure in a weighted manner to better define the nature of poor air quality that impacts breathing.

Adverse pediatric health outcomes should include both prenatal and postnatal events. Then include prematurity, small birth weight for gestational age, prenatal morbidity and mortality, and postnatal growth rates, cognitive development and respiratory disorders within the first two years of life. Outcomes should include not only acute respiratory infections such as pneumonia, but also the cumulative respiratory symptom and recurrent upper and lower respiratory infections over time. This calls for longitudinal studies of environmental exposures in addition to more specific cross-sectional studies of young children.

The working group identified the methodology of the Global Health Forum as a method for prioritizing research educational needs in India, with input from pertinent stakeholders. In addition, there was consensus that one or more interventions improving indoor air quality require study, initiating them alone and in coordination in order to assess relative efforts and interactional effects among proposed interventions. Interventions should be refined to address both generic and specific characteristics of each community and will also be culturally acceptable and inexpensive.

Concept of an Indo-US Health Science Fellowship: Focus on Environment and Respiratory Disease

There is a need for US-based physicians and scientists to better understand the environmental risks to human health in lower income countries. As an example, medical specialties such as pulmonary medicine are minimally engaged in research and training related to the environmental risks of respiratory disease; this despite the recognized importance of acute and chronic respiratory diseases in the global burden of disease. This is in part due to the lack of experience on the part of US-based investigators in clinical or training environments in lower income countries.

To address this need, the Working Group recommends the development of an ***Indo-US Health Science Fellowship*** which would provide support for a visiting faculty program at an academic institution within India targeting mid and senior level investigators with a successful track record in research in this field. In this way, the focus to stimulate an interest in global health in more senior faculty would likely create immediate impact as the returning faculty member would have a much higher success rate in seeking additional funding for global health research and training programs.

The Health Science Fellow would have a variable time commitment from one to six months. The host institution in India would commit to programmatic and administrative support as well as the availability of on-campus housing. The NIH, CDC or other funding agency would commit to support appropriate travel and per diem costs for the Fellow.

The goal of this Indo-US Fellowship Program would be to choose two or three academic sites in India characterized by academic excellence, a faculty committed to research and training relevant to environmental or occupational respiratory disease and a successful track record in meeting the health care needs of the urban and/or rural poor where risk of respiratory disease is highest.

The fellowship may evolve to include bilateral opportunities so that a physician or scientist from either India or the U.S. could participate in such a program in the other country. Similar criteria for US host institutions would need to be established to best meet the needs of Indian physicians and scientists.

Objective measures of success for this program may include:

- New research and training collaborations involving Indian and US investigators that are subsequently funded (US, India or jointly)
- New curricula or training programs for pulmonary fellows, medicine residents graduate or medical students,
- Development of joint programs between India- and US-based academic health centers or universities.

All applicants for this program would need to provide a 3-5 page proposal describing the purpose and objectives of their fellowship with evidence of support from both the parent US and host Indian academic institutions.

Summary

Each of the working groups emphasized the increasing importance of respiratory disease in India and the critical role of indoor air pollution as a major risk factor from birth to the end of life. An important need shared by all three working groups was the engagement of US-based physicians and scientists in a novel sabbatical experience in India where respiratory and environmental health issues could be addressed and studied in partnerships with leading academic centers in India. It was recommended to conduct a major prospective longitudinal birth cohort study preferably at three sites in India using an effective intervention such as safer cook stove or fuel to address the major unanswered questions regarding the health effects of indoor air pollution. This study would need to use health outcomes measures that can be practically implemented in a 5-10 year study including impact on: 1) perinatal morbidity/mortality, and 2) acute pneumonia in the first 5 years of life. Furthermore, it is critical that the study determine the dose-response effect from the products of incomplete combustion, i.e., PM and CO, on the above health measures as well as other in vivo and in vitro outcomes that will determine underlying mechanisms and risks.

Additional considerations in planning studies of IAP should use existing birth cohorts whenever possible and to include “natural experiments” in India whenever possible where widespread implementation of improved cook stoves or fuels is planned and underway. A coordinated approach to the study of IAP in India will not only determine the health risks of IAP for India but will also inform other countries where a similar burden of disease exists from IAP about the health impacts of a successful intervention program for IAP.

Key-Note Address

ENVIRONMENT, INDUSTRIALIZATION AND HUMAN HEALTH IN INDIA

Dr. N.K. Ganguly,
Former Director General, Indian Council of Medical Research,
and Advisor to the Minister of Health and Family Welfare, Government of India

Global warming and its effect on human health is an area of growing concern in both the medical and the climatological communities. Diseases such as malaria, yellow fever, dengue and cholera are all sensitive to climate. Many are spread by insects like mosquitoes, which prefer a wetter and warmer world. Deaths from the heart disease and the respiratory illness also increase during the heat waves. Malnutrition from crop failures adds to the toll.

If one attempts to map the link between the climate change and the health, one finds that the first effect of the climate change is in terms of increased human exposures to regional weather changes, heat waves, extremes of weather, precipitation and temperatures. Several modifying factors which exert their influences include the contamination pathways, transmission dynamics, agro ecosystems, hydrology, socioeconomics and demographics. The health effects occur in the form of temperature related illness(es) and death, extreme weather related effects, water and food-borne diseases, respiratory effects, vector and rodent borne diseases and effect on nutrition.

Temperature rise alters the distribution of important vector species and increase the spread of vector borne diseases to new areas. Gonotrophic cycle, daily survival and biting rates are crucial factors for vectorial capacity of these agents. In the context of water borne diseases, time-series studies on climate change and diarrheal diseases done in Peru, Fiji, Bangladesh, China and India have shown that the rise of diarrhea is linked with the temperature, rainfall and humidity. A 1°C rise in temperature is reportedly associated with 8%, 3% and 12-16% increase in diarrhea in Peru, Fiji and China respectively. This may also be linked to behavioral patterns such as the water intake and the hygiene practice. An inverse relation has been observed between GNP and diarrhea.

Health effects of the Indoor Air Pollution (IAP) include the increased incidence of childhood acute respiratory infections such as the acute lower respiratory tract infections (pneumonias), upper respiratory tract infections and otitis media. IAP has also been associated with increased incidence of chronic respiratory diseases such as bronchial asthma, COPD and pneumoconiosis; lung cancer (in relation to coal usage), pulmonary tuberculosis, cardiovascular disease and adverse pregnancy outcomes (low birth weight and stillbirth). Prevalence of cataract is the highest among women in India and may also be linked to IAP. Levels of volatile organic compounds (such as benzene, formaldehyde), carbon monoxide and total suspended particulate matter are much higher as cooking with wood than the maximum allowable levels in the indoor environment.

With regards to the Outdoor Air Pollution (OAP), suspended particles from the automobile exhaust and the industrial effluents adsorb a number of chemicals (e.g. heavy metals like lead and carcinogens like PAHs) and carry them deep into the lungs. Industrial activities cause emission of many chemicals in the environment. Many of these are known to cause endocrine disruption, mutagenesis (capable of changing quality of genetic material), carcinogenesis and harm to the fetus at low concentrations (in ppm or even ppt).

Exposures to pesticides (like endosulphan which is used as an aerial spray) over a prolonged period are associated with a significantly higher prevalence of the neurobehavioral disorders, convulsive disorders, congenital malformations in female subjects and abnormalities related to male reproductive system in the children of the exposed subjects. Toxicity of chronic arsenic exposure causes several clinical manifestations including the liver and the spleen enlargement, gastrointestinal symptoms, respiratory diseases (both obstructive and restrictive), neurological symptoms, anemia and weakness/lethargy. Cutaneous manifestations such as the skin pigmentation, keratosis and increased thickness of skin of palms and soles are also common. Men are more sensitive and prone than the women. There is also a higher incidence of different types of cancers in the individuals exposed to arsenic over a long period of time.

The National Institute of Occupational Health (NIOH) - a WHO collaborating centre- aims through research, education and services at providing help for good “occupational health” to workers engaged in all occupations and at minimizing the deterioration of environment especially that due to the industrial activities. Pesticides Analysis Laboratory and Tobacco Research Laboratory have been established at NIOH. The latter has been established subsequent to the signing of the WHO’s Framework Convention for Tobacco Control (FCTC) by the Government of India and the consequent proposal of MOHFW to set up laboratories for undertaking the task of analysis of tobacco constituents. Under the Indo-US Collaborative Programme on Environment and Occupational Health, a project on estimating bidi constituents has been proposed. A multi-centric study on the role of tobacco in the causation of cancer is being carried out and a survey on the prevalence of tobacco in two states of India (Karnataka and Uttar Pradesh) has been completed. Efforts to create awareness through mass media are also being undertaken.

ENVIRONMENTAL RISKS AND RESPIRATORY DISEASES- ICMR'S INITIATIVES

Dr. Bela Shah,
Senior Deputy Director General,
Head, Division of Non Communicable Diseases,
Indian Council of Medical Research,
New Delhi, India

As of 2005, chronic diseases accounted for more than half (5.5 million) of the total projected deaths (10.4 million). It is expected that deaths due to communicable diseases will fall by 15% over the next 10 years. Indian data on the prevalence or etiology of non communicable diseases including respiratory diseases is limited, especially in terms of a uniform definition and methodology. ICMR's priority areas in the Eleventh Plan in relation to the Environment and Health are to provide qualitative and quantitative characterization of relationships between the environmental exposures and the observed effects. The focus of research shall be on harmonizing the human health-risk assessments, predicting aggregate/cumulative risk and protecting populations. It would also aim at helping in the development of scientific understanding of biological basis of differing responses.

The ongoing research in asthma at ICMR includes a multi-centric study on the prevalence of asthma – the Indian Study on Prevalence of Asthma, Respiratory symptoms and chronic bronchitis [INSEARCH]. INSEARCH, a multi-centric study on the prevalence of asthma in different regions of India, is being conducted at 12 centers in phase II - 4 centers were completed in phase I. Differences in the prevalence of asthma, based on age groups, place of residence, gender and socio-economic status will be identified. The influence of exposure to tobacco smoke, biomass fuel combustion and other factors will also be assessed. The study involves house to house survey and interview of members aged 15 years and above. An asthma prevalence questionnaire that was developed, translated and tested for reproducibility and reliability is being used. The study is nearing completion and the results are awaited early next year.

Another multi-centric study of pulmonary function in normal adults in India is aimed at the development of reference standards for spirometry, static lung volumes and single breath diffusion capacity. This is being undertaken since the development of robust regression equations with a standardized methodology will be of immense value in research and in clinical practice especially for the diagnosis and management of respiratory diseases, such as bronchial asthma. The study will be carried out simultaneously at four centres in the North, South, East and West of India. This will represent a significant advancement in pulmonary physiology in India as the information about ethnic variations in lung function will be available. This study will also provide inputs to software manufacturers to include these data in prediction equations in equipment shipped to India. An attempt is also being made to define the reference standards for spirometry in the paediatric age group. A study of pulmonary functions in normal school going children in Delhi region aims at the development of regression equations for predicting spirometric variables in children residing in this geographical area. The other ICMR research initiatives in this field include a study on the relationship between BCG vaccination and prevalence of atopic diseases especially asthma in school children; genomic studies on asthma in Indian population; quantitative assessment of exposure to indoor-fungi in relation to sensitization in childhood asthma and studies on food as sensitizing and inducing factors of allergy disorders with special reference to bronchial asthma.

In the area of global climate change and related health effects, three task force groups have been identified all of whom would be reporting to a high powered committee. The task force on vector borne diseases and climate change would focus on ecological succession of Anopheline species in the North-Eastern states of India. Evidence based assessment of biophysical determinants of malaria in these states and development of framework for adaptation measures for malaria control under climate change scenarios will be done. The task force on eye health and environment would be associated with the conduct of a multi-centric collaborative study on the impact of global warming and Ultra Violet Radiation (UVR) exposure on ocular health in India. Another multi-centric collaborative study on the effect of Rebamipide ophthalmic suspension in treatment of UV-B induced dry eye will also be undertaken. The task force on respiratory diseases will study the impact of meteorological changes and air pollution on respiratory health and morbidity. Other areas of research for this task force would be the studies on climatic influence over longitudinally measured respiratory symptoms and lung function in healthy individuals and COPD patients; effect of ambient air pollution on cardiopulmonary functional status, clinical severity, heart rate variability and systemic inflammation in patients with asthma and COPD; and on the effect of seasonal variation on respiratory health, morbidity and mortality.

HEALTHCARE AND ROLE OF ACADEMIC HEALTH CENTERS IN INDIA

Dr. S Varma,
Professor and Head,
Department of Internal Medicine,
PGIMER,
Chandigarh, India

The primary responsibilities of medical academic institutions include manpower development, conduct of research, provision of quality care, establishment of norms for quality care and participation in policy formulation. India has got over 230 medical colleges that operate both in the public and the private sectors. Annually, approximately 25,000 undergraduate medical students, 5000 postgraduate medical doctors and several other health professionals are trained therein.

The main issues of concern with the academic institutions are related to their distribution, service versus economic considerations and accreditation. There is a need for continued professional development in view of the new and continually changing health care environments, technologic advances, changing patterns of diseases, increasing expectations and emerging health problems related to environment, occupation and life-style. The dominant issues concerning education and training of health care workers are the imbalance between health care needs and manpower development, lack of linkage causing inappropriate programs, inability to keep pace with rapid change, inappropriate numbers and lack of quality education.

A crisis in education has arisen due to the inadequate institutional numbers and mix, lack of effective accreditation or regulation, 'faculty migration' due to poor pay structure and support. There is a kind of 'students starving' due to problems related to affordability and attrition, use of outdated teaching methods and materials and lastly, stagnant or decreasing enrolment. Academic institutions need to focus on the various aspects of HRH development namely the need for different categories of personnel, program accreditation, program implementation, certification and utilization of HRH and need-based periodic modifications.

The field of postgraduate medical education has witnessed the emergence of a number of new programs over the years and a trend towards improvement in training. But several important concerns still remain unaddressed such as those related to its slow pace in India vis-a-vis the global development, inadequate number of trainees, non-uniformity in quality of programs, fragmented rather than a holistic approach and lack of training in ethics and humanities.

Subspecialty education in India has also seen rapid growth in the recent past. This is attributable to the predetermined carrier goals of individuals, professional satisfaction, prestige, perceived patient preference for specialist opinion, ease of establishing practice, and the employment opportunities. To some extent, this is market-driven and is associated with malpractice liability. As an example, more than 80% of qualified postgraduate doctors of Internal Medicine of PGIMER, Chandigarh in the last decade, underwent subspecialty training subsequent to the completion of their postgraduate training. Subspecialty, training courses that have the approval of the Medical Council of India (MCI) are available either in MCI controlled institutions or in autonomous institutions. The National Board of Examinations (NBE) also offers these courses as well as the fellowship programs. Admission to these courses is generally based on an entrance examination for individuals possessing the required basic qualifications for that particular course. At present, in India, approximately 191 and 238 positions respectively in 109 and 133 institutions are available per year for medical and surgical subspecialties, under the MCI approved domain. The corresponding figures in the NBE domain are 148 and 123 positions in 95 and 90 institutions respectively for medical and surgical subspecialties.

Academic institutions are involved in health care delivery through patient care, participation in national programs and medical education. The problems that exist are related to the disparities in the standard of care, influx of patients at few centers and the economic issues. Their contribution to policy making and planning in the general health issues is somewhat inadequate. Research and health care delivery should focus on locally relevant problems, epidemiology, development of cost effective treatment strategies, preventive strategies and educational research.

In summary, academic institutions contribute significantly to health care through direct participation as well as HRH development. There is a need for these institutions to remove disparities, improve the accreditation and monitoring processes and serve as vehicles of change for better health care and improve linkages with wider issues on health perspectives. There is much large scope for these institutions to play a greater role in the issues of national and global importance such as those related to the health, effects of environmental pollution, climatic changes and occupational exposures.

PREVALENCE OF RESPIRATORY DISEASES IN INDIA

Dr. Dheeraj Gupta,
Additional Professor,
Department of Pulmonary Medicine,
PGIMER,
Chandigarh, India

India's population of over one billion in the presence of significant geographical, religious, social, cultural and culinary diversity makes it an 'epidemiologist's nightmare' but has the potential to be a 'researcher's dream'. As per data available from the National Family Health Surveys (NFHS), approximately half of all households still utilize the burning of wood as their primary source of fuel for cooking. But the percentage utilizing liquefied petroleum gas (LPG) for domestic cooking has steadily increased from 11% in 1992-93 (NFHS-1) to 25% in 2005-06 (NFHS-3). Kerosene, dried dung cakes and coal serve as the other important domestic cooking fuel sources. The number of persons per room while sleeping has also changed considerably. According to the NFHS-1 findings, 60% and 24% of households had less than 3 and 3-4 persons per room; the corresponding figures are 44% and 34% respectively in NFHS-3.

Information on epidemiology of chronic respiratory problems in India was scarce till recently, primarily available through some small and sporadic studies conducted by individual investigators. Respiratory infections and other respiratory diseases are the 3rd and 7th highest causes of disease burden in terms of disability adjusted life years (DALYs) in India. India, China and other Asian countries are likely to witness the largest increase in tobacco related mortality in the coming years. Prevalence of 'chest symptomatics' was around 12% in a community survey conducted at PGIMER, Chandigarh in 1999-2000 with a higher prevalence in individuals who were males, illiterate, above 44 years of age and residing in urban areas. The three most probable diagnoses were COPD (28.6%), asthma (36.4%) and PTB (17.1%).

The median prevalence of COPD in India is estimated from different population studies was 4.1%, with a smoker to non-smoker ratio of 2.65:1. There was a wide range (1.5-12.5%) of prevalence reported in the field studies published over the last 30 years. Based on these figures, the number of patients with COPD was estimated at 10.7 and 5.48 million males and females respectively in 2004, likely to reach 13.9 and 7.13 million respectively by 2014. Asthma prevalence in India has been variably reported in different studies and ranges from about 2.3 to > 10 percent in children and 2.4 to 3.5% of adults.

Tuberculosis remains an important concern. The overall prevalence of reported as well as of medically treated TB was 445 and 418 per 100,000 people in NFHS-3. Females had rates around 60% of those in males. In comparison to NFHS-2, the reported TB had declined by 18% but the level of medically treated TB had not changed. In NFHS-3, the prevalence of TB was around 110, 519 and 998 per 100,000 people in age groups of less than 15 years, 15-59 years and more than 60 years of age. The prevalence had always been the highest in the north-eastern states of India. It was also grater in households using solid fuels for cooking.

Estimates of mortality from respiratory disease are difficult to obtain because of the paucity of information, in particular, about non-neoplastic lung diseases. Mostly these figures are based on those provided in the WHO's Global Burden of Disease Study (GBDS). Less than 15% of deaths are medically certified in India since medical certification on cause of death (MCCD) is optional. From the limited data which are available, it is assessed that respiratory illness, as a group, is the sixth leading cause of death. 'Bronchitis, chronic and unspecified, emphysema and asthma' together constitute the second most common cause after 'pneumonias and infections'. An assessment of causes of death using lay-diagnosis reporting (post-death 'verbal autopsy') was conducted in 1994 in rural India. The survey involved a population of approximately 4.1 million and data were collected on 36799 deaths. Estimates of crude mortality available from this survey indicate that “asthma and bronchitis” is the leading cause of death, while pneumonia and tuberculosis are the other respiratory illnesses that are listed among the top ten causes of death. According to other sources, respiratory illnesses were responsible for almost 2.8% of all deaths in India in 1990 and this is likely to rise to 6.5% by the year 2020. Thus, respiratory diseases are major contributors to overall mortality in India.

PREVALENCE OF RESPIRATORY ILLNESSES IN INDIA

Dr. Gregory B. Diette,
Associate Professor of Medicine, Epidemiology and Environmental Health,
Johns Hopkins University, USA.

The major respiratory illnesses with environmental risks are asthma, chronic obstructive pulmonary disease (COPD), lower respiratory track infection (LRTI), tuberculosis (TB), bronchiectasis and interstitial lung disease (ILD).

The International Study of Asthma and Allergies in Childhood (ISAAC) was a systematic, standardized comparison of prevalence of asthma and allergies. It was a school-based survey conducted in 39 languages at 155 Centers in 56 countries all over the world. Although India was among the countries that had the lowest prevalence rates, there were significant geographical and regional differences. Some centers in India infact reported prevalence rates that were as high as 17.9%. Subsequently, there have been several other community/school epidemiological studies including ISAAC Phase III that have utilized validated questionnaires for assessing the prevalence of asthma in children and adolescents. Data from these studies suggest that the estimated prevalence of asthma is between 2-4%. However, higher prevalence rates have been reported in case of hospital based studies and for respiratory symptoms especially the wheezing and the exercise-induced bronchospasm.

Asthma prevalence in adults in north India was first systematically assessed by PGIMER, Chandigarh during 1995-97. This was by means of a validated questionnaire administered to approximately 2000 adults residing in urban and rural areas. It was also supplemented with peak expiratory flow rate (PEFR) and/or spirometric measurements. The estimated prevalence in men and women was approximately 4.0% and 1.3% respectively. A multicentric (INSEARCH) study for assessing the prevalence of asthma is currently underway. Importantly, the issues in asthma prevalence studies are related to the diversity in geographic areas, the study time periods, sampling strategies, demographic targets (e.g. age, social class), survey methodology and type of questionnaires, definition of asthma and the use of lung function testing.

Different definitions of obstruction and prevalence of COPD have been reported in the past. The estimated prevalence of COPD in India ranges from 1.9-21.7% in men and 1.3-19% in women. The wide range again is attributed to some factors as for asthma mentioned above. Diagnosis of COPD, as of now is based on spirometry and its severity gradation on post-bronchodilator value of forced expiratory value in the first second (FEV_1). Presence of symptoms, inflammation and computed tomography (CT) findings are not taken into account by the current method for diagnosing this disease. Moreover, the use of pre-bronchodilator spirometry results in over-diagnosis and overestimation of severity of COPD. There are some peculiar situations where individuals have been documented to have airflow obstruction on spirometry but symptoms are either absent or not documented and vice versa. It is also important to note while assessing individuals for presence of respiratory symptoms (in particular chronic cough with expectoration) that the same can be caused by several other conditions such as bronchial asthma, gastro-esophageal reflux disease (GERD), rhino-sinus conditions and non-asthmatic eosinophilic bronchitis.

Issues for future estimates of respiratory disease prevalence in India include denominator issues, numerator issues and the repeatability. The denominator issues involve the sampling resources (e.g. census track data), the sources of sample (community, work, school, health care facility), selection criteria to include or exclude the subjects (e.g. migrants) and the stratification of samples (urban/rural, social class, smokers). The numerator issues relate to the standardization of diagnosis, definition, survey and lung function. Repeatability is important to estimate the change over time.

CHALLENGES OF RESEARCH IN RURAL INDIA

Dr. Rajesh Kumar,
Professor and Head,
School of Public Health,
PGIMER,
Chandigarh, India

Status of health research in India is currently uneven while the basic sciences and the clinical research form a major chunk (49% and 47% respectively), research in public health comprises of only 4% of health research. Elsewhere in terms of quality of research, the impact factors for research in basic sciences, clinical and public health are 16 times, 27 times and 31 times more in Australia after adjustment for population and GDP. On the other hand, Indian Public Health research remains a neglected field as can be seen from the following analysis:

Type of public health research	**Original papers**
Population Epidemiology	46.6 %
Biostatistics/ Methods	2.0 %
Environmental Sciences	9.5 %
Social Sciences	11.5 %
Health Services	28.4 %
Health Policy	2.0 %

Epidemiological data sources are mainly three – namely vital events registration (which provides causes of deaths), disease surveillance (available through notifications and registries in both public and private health sectors) and national health surveys (available through lay reports and examination).

The problems of research in rural settings in India are related largely to the poor rural infrastructure and logistics. There is lack of all weather roads to most villages, frequent interruptions of electricity and water supply, inadequate accommodation for staff and a weak health infrastructure. The rural health service providers are generally overburdened and hence most patients seek medical care from ‘informal medical practitioners’. There is a mismatch between research requirement and rural medical practice due to lack of the appropriate and affordable technology.

Data collection in rural areas is also associated with certain problems. There are difficulties in questionnaire administration and interviewing of people. Conduct of physical examination is even more difficult. Illiteracy, language differences, socio-cultural-gender sensitivity and issues related to privacy, confidentiality and autonomy are some of the factors responsible for these difficulties. Timing of visits for data collection especially when coinciding with sowing, harvesting and festival seasons also pose problems. There are also important ethical issues for conduct of public health research, such as the service versus research; informed and written consent; and risk probability versus benefit to research participants and their communities.

The future for public health lies in giving appropriate prioritization to public health research by linking essential health research to service delivery. There is a need to involve and consult the community, enter into discussion with service providers and community leaders. Adaptation of research methods with use of appropriate technology as well as capacity building (of human resources and infrastructure) is also crucial. Simplifying administration and fiscal procedures as well as sustaining funding are other important steps to help public health research in the rural settings.

CHALLENGES OF RESEARCH IN RURAL AREAS IN THE US

Dr. Randy Wykoff,
College of Public Health,
East Tennessee State University, USA

Research in rural areas of US is important since 22% of the US population (approximately 65 million) live there. These Americans suffer significant disparities related to socio-economic status, access to healthcare, educational attainment and health outcomes. There are several challenges conducting research in rural areas which can be related to the people, the region, the researcher, or the study.

Challenges related to the people mostly pertain to the socio-economic disparities, lack of access to health care, a particular tradition of health care, and lower educational attainment/literacy in rural population. In addition, alternative cultural beliefs with respect to the concepts of disease, autonomy of self versus of the group, and gender roles can also impact the conduct of clinical trials in rural areas.

Challenges related to the region are in the form of poor social infrastructure, low population density, high population mobility and other confounding factors. The limited rural health infrastructure may also be also responsible for a lack of historic data and for inability to make the required diagnosis and provide clinical care during or after a study.

Challenges related to the researcher can arise from the fact that he/she may not be asking the complete question or asking the wrong question. Often the question isn't just "does this product work?" but actually, "does this product work *here*?" In addition, there may be a lack of understanding of the additional challenges that are related to ethical protections namely informed consent, IRB/independent review and patient confidentiality that may occur in a rural area. Cultural differences may limit the willingness to participate in a trial and could be related to differences in language or unwillingness to trust the researcher. The latter may be related to previous negative experiences with medical research.

Challenges related to the study can arise especially since some types of studies may not be possible in the particular geographical area being considered. There could be either lack of "historic" data, lack of healthcare means and thus lack of "diagnosis" or of the ability to conduct follow up interviews or examinations. Moreover, some types of studies may not be sufficient. It requires 'a product' to be shown as "safe and effective" and yet be culturally acceptable, functionally affordable, and realistically accessible.

These challenges can be addressed by increasing community participation, paying close attention to ethics and patient protection, taking the cultural awareness and sensitivity into account and making an attempt to develop a true long-term relationship. The National Bioethics Advisory Commission (NBAC) recommends, among other things, that while attempting to perform clinical trials in developing countries, the research plan must receive prior review by an independent Ethics Review Committee. Efforts must be made to minimize the risk to research participants and the research must involve a reasonable risk-benefit ratio. Also, adequate plans for the care and compensation of participants for injuries directly related to the research, should be made. Individual informed consent must be obtained from all participants who must receive equal consideration and care. There must be an equitable distribution of the burden and benefits of research.

While conducting medical research in rural areas may present additional challenges, it remains critically important to the health and welfare of people living in those areas.

ENVIRONMENTAL RISKS OF RESPIRATORY DISEASE IN INDIA WITH A FOCUS ON EXPOSURE REVIEW FOR OUTDOOR AND INDOOR AIR POLLUTANTS

Dr. Kalpana Balakrishnan,
Professor & Head,
Department of Environmental Health Engineering,
Sri Ramachandra University,
Chennai, India

In the past, the status of air pollution related exposure information was limited to that from a few cities wherein limited monitors operated on limited days for monitoring a few pollutants in urban outdoor settings. No routine monitoring information was available on indoor air pollution related to solid fuel use. Most epidemiological investigations were limited by exposure misclassifications because of an extensive range of exposure determinants.

Indoor, outdoor and occupational exposures often lead to competing microenvironments. Hence there is a need to set up a framework for tiered exposure assessment which should include estimates of personal as well as community exposures at one end and of city, state and national exposures at the other end. In one exposure assessment survey urban outdoor air pollution (OAP) was monitored at 341 stations across 126 cities in 25 states and 4 union territories (UTs) in India where 78 non-attainment cities and 24 critically polluted areas were identified. Commuting and /or staying close to high traffic areas contributed the most to pollutant exposures in some cities like Chennai.

Indoor air pollution (IAP) is now being monitored with assessment of fuel usage at the national/regional level, household fuel use at the sub-national level, household fuel use in relation to housing characteristics, household air concentrations without and with time activity patterns and finally, with the help of personal monitoring and use of biomarkers.

Traditionally rural IAP and urban OAP have constituted the focus of inputs for research and development. But there is an increasing evidence now to suggest the importance of both urban IAP and rural OAP which need to be evaluated with the same amount of inputs and efforts. A sequential assessment of exposures, health impacts and control options needs to be done for each of the four major areas namely, rural IAP, rural OAP, urban IAP and urban OAP.

INDOOR AIR POLLUTION AND RESPIRATORY DISEASE IN INDIA

Dr. Kirk R. Smith
University of California,
Berkeley, USA

Respiratory diseases account for about 15% of total disease burden in India which is higher than the corresponding figure of 9.2% in USA. Acute lower respiratory tract infections (Ac LRTIs), tuberculosis (TB) and chronic obstructive pulmonary disease (COPD) are the three important respiratory diseases which contribute to 8.6%, 3.0% and 1.9% of the total disease-burden in India, respectively. A smaller yet important burden is also attributed to asthma, and in cases of adults, to lung cancer. Other respiratory diseases whose burden of disease is small and yet have an important economic impact include otitis media and acute upper respiratory tract infections.

In most of the geographical regions of India, the percentage of households that use biomass fuels as energy sources is either ≥75% or between 50-74%. Typical biomass cooking stoves convert 6-20% of the fuel carbon to toxic substances as a result of simple (poor) combustion. Wood, roots, crop residues and cattle dung are among the fuels which produce a high percentage of pollutant emissions. On the other hand, kerosene, liquefied petroleum gas (LPG) and biogas are the cleaner fuels. The health-damaging air-pollutants from the typical wood-fired cooking stoves in India include carbon monoxide, the particulate matter, hydrocarbons (like benzene and 1,3-butadiene), oxygenated organics (like formaldehyde) and chlorinated organic compounds. All these constituents are present in higher than acceptable concentrations in the households which use the biomass fuels. Some of them are infact proven or probable carcinogens.

Evidence linking the indoor air pollution (IAP) to one or more specific diseases (including those of the lungs) exists for several disorders in the form of epidemiological studies.

There is reasonable evidence that IAP is a risk factor for ALRI in children and COPD in adults. A similar level of evidence also exists for coal burning and lung cancer in adults. The level of evidence linking biomass fuel use and occurrence of lung cancer and tuberculosis in adults is modest. However, there is suggestive evidence for a causative association between IAP and occurrence of ac LRTIs in adults and asthma in both children and adults. In case of children, IAP may have indirect respiratory impacts primarily by an increase in the incidence of low birth weight babies.

Important interactions exist between several other environmental pollutants and IAP that can adversely affect the human health. Presence of excess of arsenic in water, "the largest poisoning in human history" leads to COPD, lung cancer and ALRI. There may be interactions with IAP, but this has not been well studied. Other important interactions with IAP include those related to high occupational exposures to various dusts (like silica and asbestos), malnutrition and smoking.

Biomass smoke is a global concern and contributes significantly to $PM_{2.5}$ emissions around the world, particularly in rural areas of developing countries where such fuel dominate. For example, the wood heating and fireplace-use is common in many developed countries and is constantly growing because of the increasing energy-prices. It is not clear whether its effects on all major health outcomes are the same as those found in urban studies of PM. It is likely that the households in the low-income and the developing countries represent perhaps the only widespread exposure to nearly pure biomass smoke. The total biomass PM emissions per capita may remain more or less same at different levels of income. But the fact remains that with the increasing per capita income, the biomass PM emissions decrease at the indoor level while they increase at the outdoor level.

Biomass fuel use in the households is also associated with a high level of methane emission. The latter, along with nitrogen oxide emissions, is the main cause for the global increases in background ozone concentrations and is also a source of global warming. Hence it is necessary to reduce the quantity of methane emissions. This has several other benefits as well such as in reducing the global radiative forcing and in preventing premature deaths.

In conclusion, the products of incomplete combustion are both health-damaging and climate-warming. Efforts to reduce them in the household combustion can be highly effective and co-beneficial to achieve both the goals of preventing the health-damage and the climate-warming.

QUANTIFYING THE HEALTH EFFECTS OF AIR POLLUTION: PLACING INDIAN STUDIES WITHIN A GLOBAL CONTEXT

Dr. Sumi Mehta
Health Effects Institute, USA

The Health Effects Institute (HEI) has developed a strategic plan from 2005 -2010 for understanding the issue of air pollution and health on a global scale. This will include working on the toxicity of particle components and gases, measuring the health impacts of air quality actions (accountability), the potential health effects of "traffic" and emerging technologies and fuels (ACES study).

The Public Health and Air Pollution ('PAPA') Program is being undertaken in Asia to understand the health effects of air pollution. It is supported by US AID, ADB, industry and other foundations. It aims at assessing the state of air pollution and health across Asian cities. A series of epidemiological studies in representative Asian cities (including 3 in India – Chennai, Delhi and Ludhiana) have been initiated to estimate local impacts. The results can then be extrapolated throughout the region. Along with this, strengthening of the network and capacity building of the local scientific pool will be done with the overall goal of improving Asian information, regulatory and policy decisions.

Air pollution has many constituents. The important air pollutants are the carbon monoxide (CO), carbon dioxide (CO_2), particulate matter (PM) [size differentiated as PM_{10}, $PM_{2.5}$, ultra fines etc.], sulfur dioxide (SO_2), ozone (O_3), nitrogen oxides (NOx, NO_2) and hydrocarbons (HC). In addition, there are PM and O_3 precursors. NO_2 is an indicator of traffic pollution. Other constituents include lead, diesel exhaust, air toxins, aldehydes (formaldehyde, acetaldehyde, and others), benzene, 1,3-butadiene, methanol and polycyclic organic matter (e.g. PAHs).

The relationship between outdoor and indoor concentrations and their impact on personal exposures is complex. The outdoor sources are not only responsible for the outdoor exposures, but also for the indoor exposures depending upon the extent of infiltration and penetration. The largest exposure to the outdoor sources of air pollution may in fact occur indoors. Similarly, the indoor sources are not only responsible for the indoor exposures, but also for the outdoor exposures in the neighborhood, depending upon the status of ventilation.

Air pollution affects the mortality or the morbidity both in the short-term (through transient effects and by causing exacerbation of pre-existing disease), and in the long-term (through the developmental effects, as an added risk factor for causation and/or induction of a chronic disease).

The techniques to assess the health effects of air pollution comprise of toxicological, human clinical or epidemiological measurements. The epidemiological assessments are made with the help of cross-sectional, time-series, case control and cohort studies. Panel assessment and interventional approaches also constitute an integral component of the epidemiological study. The common health effects reported from short-term exposure studies are the following:

Type of effect	**Details**
Mortality	Cardio-respiratory
Hospital admissions	Cardio-respiratory
Emergency room attendances	Cardio-respiratory
Primary care visits	Upper and lower respiratory
Respiratory symptoms	Cough, phlegm, wheeze
Use of medications	Asthma drugs
Lung function	Restrictive and obstructive
Blood	Increased viscosity, fibrinogen
Heart	Heart rate variability, arrhythmia

The health effects observed in long-term exposure studies include an increased adult mortality, permanent reduction in lung function, increased incidence of chronic respiratory symptoms and bronchial asthma. There is also an increased incidence and mortality of lung cancer. The perinatal effects include an increased infant mortality and increased incidence of SIDS, prematurity and low birth weight. Associations between mortality and long-term exposures to fine particles ($PM_{2.5}$) have also been observed.

While air pollution poses clear health effects, the bulk of the evidence is available from the urban areas of the developed countries. In certain Western European countries, 6% of all deaths are attributable to the outdoor air pollution. It is quite likely that the burden is higher for developing countries where average outdoor and indoor air PM_{10} levels are greater than those in the developed world. But the extrapolation of the Western research to Asian populations is challenging, and often inadequate since the pollution sources, the mixes and the competing risk factors are different. Moreover, population characteristics and relevant health effects often have not been fully addressed or have been overlooked.

The estimated annual outdoor particle concentrations in cities across the globe show a wide range, with many of the most polluted cities located in the developing countries of Asia, Africa, and Latin America. But only a few major cities in any region, including those in developed countries, meet the WHO Air Quality Guidelines published in 2005. Moreover, there is a significant lack of basic measurements for the rural areas and for the smaller cities, where things may be as bad or worse. Recent advances in measurement (such as availability of satellite data and in the spatial modeling of air pollution) may help to provide wider global coverage where traditional measurement methods are not currently feasible. But more detailed studies of air pollution exposures from multiple sources in the developing countries are clearly needed; if for no other reason than to inform the development, application and interpretation of the results of such methods. Fortunately, such studies are beginning in the cities in Asia, Africa and Latin America.

In India, 44 studies have been conducted between 1980 – 2007 in this area, mostly from the northern and western regions. Most of the studies have evaluated respiratory-related symptoms and diseases using cross-sectional study designs. Exposure assessment has been done in about half of them by means of measurements of exposure to both PM and gaseous pollutants. In the rest of the studies, the estimated effects of exposure have been made on the basis of residential proximity to air pollution sources and haze.

The biggest limitation of health research in India is the lack or non-availability of historical data on air quality and mortality for air pollution. The recent developments in data collection in the availability of electronic hospital records and the continuous air quality monitoring are encouraging. India has a good technical capacity for clinical epidemiology and personal exposure assessment. The future directions for research in India in this area may include the expansion of time-series approach to other cities and to assess morbidity outcomes. Other study designs can also be used for conducting research. Public health research priorities should focus on key health endpoints (infectious diseases, including ALRI and possibly tuberculosis, cardiovascular disease, and adverse pregnancy outcomes), age groups (e.g. young children) and subpopulations (e.g. urban slums) that have not been addressed/studied previously. Lastly, there is also a need to focus on total exposures (indoor and outdoor sources). Demographic transitions have led to the epidemiologic transitions and hence the transitions in environmental risks. Traditional risks such as the use of solid fuels for cooking, although important as of now may become less significant with time. With the continued and progressive economic development, the modern risks like those related to vehicular traffic are becoming increasingly more important.

RESPIRATORY EFFECTS OF OUTDOOR AIR POLLUTION

Prof. S. K. Chhabra,
Vallabhbhai Patel Chest Institute,
New Delhi, India

Outdoor air pollution (OAP) adversely affects the lung functions and increases morbidity due to respiratory illnesses. OAP is also associated with increased hospitalization rates for acute respiratory episodes (asthma, COPD) and acute coronary events to the tune of 20-25%. Suspended particulate matter (SPM) concentrations have been shown to have a significant positive correlation with the number of COPD cases. Similarly, the high levels of sulphur dioxide (SO_2) in urban areas have been shown to increase the prevalence of respiratory symptoms such as dyspnea, chronic cough and frequent colds. Exposure to increased ambient air concentrations of SPM and SO_2, remaining indoors while food is being cooked with biomass fuels, are associated with increased incidence and duration of respiratory symptoms in pre-school children living in urban slums. In addition to respiratory symptoms, adverse effects of OAP in urban children are also reflected by an increase in the number of alveolar macrophages.

In a study on the effects of OAP on chronic respiratory morbidity in Delhi using a standardized respiratory symptoms questionnaire and clinical assessment by chest physicians, it was found that nearly 25% of interviewed residents (n = 4141) had chronic respiratory symptoms. Individuals residing in higher pollution areas had higher prevalence of chronic cough and chronic phlegm. Smoking was the major determinant of respiratory morbidity while lower socioeconomic status, older age and male sex were the other significant risk factors. Lung function was better among both male and female subjects living in the lower pollution areas. Similarly, the prevalence of chronic respiratory symptoms and obstructive ventilatory defects is higher in industrial towns compared to non-industrial towns, and this is attributed to the higher concentrations of total SPM, oxides of nitrogen, SO_2, carbon monoxide (CO) and ozone (O_3).

Particulate air pollution correlates positively with daily mortality both in terms of total number of non-traumatic deaths as well as deaths from respiratory/cardiovascular problems. The impact observed in India is smaller than those estimated for other countries. For example, a 100 μg/cu m increase in total particulates leads to a 6% increase in non-traumatic mortality in developed countries while in Delhi, such an increase in particulates was associated with a 2.3% increase in deaths in a recent study. This difference could be attributed to the fact that in Delhi, a greater proportion of deaths occurred at younger ages and from causes not associated with air pollution than was the case in the U.S.

The adverse health effects of air pollution extend beyond the lungs. The cardiovascular system (CVS) is the other major vital body system which is affected. Increased cardiovascular mortality and morbidity have been observed on days/time periods associated with an increase in OAP. There is a significant increase in the risk of ventricular arrhythmias, acute myocardial infarction and an increase in hospital admissions for heart failure. In addition, reduced heart rate variability has been documented with particulate pollution and ozone and this may be the underlying reason for increased cardiovascular-related mortality.

There is a great interest on systemic inflammation as the cause for the observed adverse effects of OAP. The particulate matter (particularly $PM_{2.5}$ and PM_{10}) is pro-inflammatory, pro-thrombotic, pro-atherosclerotic and pro-arrythmogenic. Systemic inflammatory response and systemic oxidative stress are reflected by the increased plasma concentration of C-reactive protein (CRP) which is recognized as a marker of inflammation and a factor in the pathogenesis of atherosclerosis. Increased coagulability, increased viscosity and increased markers of endothelial dysfunction, all point to the fact that air pollution promotes atherosclerosis with all its well known consequences.

It can be summarized that air pollution is associated with excessive cardio-respiratory mortality and increased health-care utilization both in terms of hospitalization and emergency room visits. Exacerbations of asthma and COPD lead to increased physician visits and decreased peak flow readings. Increased prevalence of respiratory symptoms and reduced spirometric indices reflect impaired lung functions, increased airway reactivity and thus higher burden of respiratory illnesses. Increased lung and systemic inflammation lead to the alterations in the host defenses, macrophage function, immune response and mucociliary function.

KNOWLEDGE GAPS AND RESEARCH PRIORITIES OF RESPIRATORY HEALTH EFFECTS OF AIR POLLUTION IN INDIA

Dr. J.S. Thakur
School of Public Health, PGIMER, Chandigarh, India

India is a developing country undergoing health transition, rapid urbanization, industrialization and motorization. Due to this environmental, occupational and life style diseases are emerging as important public health problems. About 75% of India population lives in rural areas and 30% below the poverty line. Air pollution is emerging as an important public health problem. In general, combustion is the chief process responsible for air pollution. The main source of combustion is fuel usage and vehicle emissions, which tend to increase along with increases in population size and economic activity. Open burning of paddy husk in agriculture, forest fires and refuse burning are also common causes leading to air pollution. Because of energy crisis, more coal-based power plants are being established compounding the problem of air pollution.

Besides this, indoor air pollution is also a growing concern in India. As per National Family Health Survey-3, 75% of population use biomass fuel and only 25% LPG as a cooking fuel. Indoor smoke ranks 3rd among the top ten risk factors in Indian burden of diseases. Cooking in living rooms is common in rural and urban slum areas of the country. About half a million women and children die each year from indoor air pollution in India. Compared to other countries, India has among the largest burden of disease due to the use of household fuels. It is estimated that 28% of all deaths due to indoor air pollution in developing countries occur in India.

Respiratory diseases constitute about 15 % of the total disease burden in India. The common respiratory diseases which have a proven association with air pollution are tuberculosis, pneumonia, COPD, asthma, lung cancer and pneumoconiosis. Various studies have shown that acute lower respiratory tract infection has a strong association with indoor pollution due to solid fuels (odds ratio of 2), which is an important cause of childhood morbidity and mortality in India. About 30% of newborn babies are of low birth weight and the prevalence of malnutrition is 46% in children below 3 years of age as per NFHS-3. It appears that air pollution is playing a role in poverty-malnutrition-infection cycle in the county.

However, there are very few studies related to the health effects of air pollution in India. After an extensive search, it was found that only 44 studies have been conducted on health effects of air pollution in India till 2007, mostly in North and West India. However, about 17 have studied respiratory health effects of air pollution. The main study designs were either cross-sectional prevalence studies of chronic respiratory symptoms or of pulmonary function or time-series studies of the effects of short-term exposure on daily mortality or hospital admissions. Certain studies had also tried to find an association between air pollution with cancer risks and cardiovascular health status. Increased level of air pollution showed an increased risk of association with various acute and chronic respiratory symptoms, morbidity and mortality.

There are many knowledge gaps due to lack of evidence. We need to understand how short-term exposures to outdoor air pollution are related to daily morbidity and mortality across India. Smaller isolated studies have been conducted. Recently three time series studies were conducted in Ludhiana, Delhi and Chennai which may not be enough for a big country like India. Air pollution sources in developing Asian cities including India differ from those in the West. So the resulting urban air pollution mixture may differ as well. Hence detailed studies of the composition of air pollution and relative contribution of various sources are not yet conducted extensively in India. The magnitude and exposure to indoor air pollution is high especially among the urban and rural poor because of cooking habits, poor ventilation and overcrowding but very few studies are available. We also need to understand better how air pollution from indoor sources contributes to levels of outdoor air pollution and vice versa. Limited evidence, largely from studies in Europe and North America, suggests that economic deprivation increases the risk of morbidity and mortality related to air pollution. So role of air pollution in vicious cycle of Poverty-Malnutrition-Infection need to be further studied. There are many research challenges in the country, which include diverse geographic areas, many languages, cultural diversity and poor disease surveillance system. Environment and occupational health is still a neglected subject and few scientists are working in this area in the country.

There is need to expand time series approach to other cities focusing on morbidity and cause specific mortality. Second wave of similarly designed time series studies need to be further conducted in various parts of the country. More studies on indoor air pollution are needed in the country. There should be a focus on total exposure including indoor and outdoor sources. Occupational respiratory diseases are ignored and need attention. There is a need to undertake country specific systematic reviews for common health effects so that evidence based public health interventions could be initiated. Community based participatory research is needed for effective interventions. Appropriate green technologies should be promoted which is possible for our country because of its developing status. We need to identify key research questions, set our research priorities, identify key institutions and scientists and build their capacity to undertake further research in this area. We should not wait till we have enough evidence to act. However, evidence available from other countries could be used for undertaking policy initiatives for controlling the adverse health effects of air pollution in India.

CHALLENGES AND FUTURE DIRECTIONS IN OUTCOME MEASUREMENTS OF INDOOR AIR POLLUTION - SPOTLIGHT ON PNEUMONIA

Dr. Archana Patel,
Professor and Head, Department of Pediatrics
and Director, Clinical Epidemiology Unit,
Indira Gandhi Govt. Medical College, Nagpur, India

Dr. Patricia Hibberd
Professor, Departments of Public Health and Family Medicine, Medicine and Pediatrics
Tufts University School of Medicine
Boston, USA

Indoor air pollution (IAP) is responsible for 2.7% of the global burden of disease[1]. IAP associated with the use of biomass fuels is reported to kill nearly one million children annually, mostly as a result of acute respiratory infections (ARI). But questions have been raised about the contribution of IAP to deaths from ARI, because of variable definitions of ARI in IAP studies.

The World Health Organization (WHO) classifies ARI as either Acute Upper Respiratory Infection (AURI) - common colds, ear infections, sore throats, croup and bronchitis), or Acute Lower Respiratory Infection ((ALRI) - pneumonia, severe pneumonia and very severe pneumonia[2]. Pneumonia is the leading cause of death in under-five year old children in low resource settings and accounts for approximately two million deaths in this age group annually[3-5]. The WHO focuses is on early detection and community management of community acquired pneumonia (CAP) in resource poor settings using clinical signs that can be reliably assessed by community health workers. Specifically, a child aged 2-59 months with cough and age-specific fast breathing lasting less than 14 days is considered to suffer from very severe pneumonia (VSP) if the danger signs are present, severe pneumonia (SP) if there are no danger signs but lower chest in-drawing (LCI) is present, and pneumonia if there are no danger signs and no LCI.

The WHO-criteria for diagnosis of ALRI are non-specific and overlap with many conditions such as hyper-reactive airway disease, foreign body aspiration, poisoning, trauma, neurological conditions, congenital heart disease and other respiratory/gastrointestinal/neurological and congenital conditions. There is also much confusion in the literature about the diagnosis of pneumonia, variably described as bronchopneumonia, bronchitis or bronchiolitis. To understand the role of IAP in respiratory tract morbidity and mortality, there is an urgent need to refine the criteria for diagnosis of AURI and ALRI for use in the IAP studies.

We presented data from two large randomized multi-country trials conducted in collaboration with the WHO. The first study was the Amoxicillin Penicillin Pneumonia International Study (APPIS) comparing WHO standard treatment (injectable penicillin) with oral amoxicillin in children with SP[6]. The second study was the Severe Pneumonia Evaluation Antimicrobial Research (SPEAR) study comparing standard treatment (parenteral chloramphenicol) with parenteral ampicillin and gentamicin in children with VSP[7]. These studies were used to evaluate ways to attempt to more precisely diagnose pneumonia and predicting outcome after antibiotic treatment.

The APPIS study that enrolled 1,702 patients showed that treatment success with oral amoxicillin and injectable penicillin were equivalent for the treatment of SP. Our group conducted secondary data analysis from this trial to assess the ability of clinical variables, chest radiographs and pulse oximetry to predict treatment failure[8-11]. The age of the child, and the respiratory rate in excess of the age specific cut-offs at baseline and at 24 hours of hospitalization had a 70% and 66% ability to predict the failure of antibiotics to treat SP[8]. Chest radiographs were difficult to use because of the poor agreement between the three independent observers, despite the use of a simplified categorization of radiographic features. This agreement improved moderately after training[9]. But when chest radiographs were categorized as having "significant pathology" vs. no pathology, penicillin-resistant *Streptococcus pneumoniae* was more likely to be isolated from the nasopharyngeal isolates[10]. Detection of hypoxia by pulse oximetry predicted antibiotic treatment failure when measured at baseline, 12 and 24 hours of observation)[11].

Ampicillin and gentamicin were superior to chloramphenicol in the SPEAR trial. Bacteremia (any organism) occurred in 11% of the 958 patients in the study and was associated with an increased the risk of antibiotic treatment failure at 21 days[7]. The common blood or lung isolates in this study were the *Staphylococcus aureus* (n=47), the *Streptococcus pneumoniae* (n=22) and others (n=31).

These studies demonstrate that 1) specific clinical variables and pulse oximetry are useful in determining which children will fail antibiotic treatment for SP and VSP and 2) that treatment failure was associated with bacteremia in VSP. But neither trial had addressed the potential role of IAP in CAP. There is also an important need to diagnose bacterial from viral pneumonia based on antigen tests of nasopharyngeal isolates and the blood cultures. It is also important to establish improved criteria to distinguish bacterial or viral pneumonia from the hyperreactive airway disease.

Collaborations between IAP experts and research networks, such as the Global Network for Women's and Children's Health Research (*Eunice Kennedy Schriver* National Institute for Child Health and Human Development) and other agencies, such as the National Institute of Environmental Health Sciences (NIEHS) may provide an opportunity to address these questions and move this important research agenda forward.

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ENVIRONMENTAL RISKS OF TUBERCULOSIS IN INDIA

Dr. Virendra Singh
Professor in Pulmonary Division, Department of Medicine,
SMS Medical College, Jaipur, India

Among 8.8 million new cases of tuberculosis every year 20% are from India. Annual incidence of TB in population is 1.68 per 1000 people. However, in medical personnel caring TB patients it is almost 10 times higher.[1,2] Extra pulmonary tuberculosis was more common in health care workers (HCW). Low body mass index and working in medical wards were identified as risk factors. Almost 50% HCW were found to have latent infection as detected by Montoux test. Annual risk of contracting latent infection was 5% which is much higher than that of general public (1.5%).[3]

Overcrowding may be an important factor in spread of tuberculosis. It has also been shown in a study which evaluated possibility of spread of TB among patients of a ward. Genotypes of Mycobacterium tuberculosis of 83 isolates showed overlapping hospital period, suggesting a possibility of nosocomial infection.[4] Recently, smoking has been identified as a risk factor in causation of tuberculosis in a study based on verbal autopsy.[5]

Proper patient and public education emphasizing healthy habits such as cough hygiene, proper ventilation of closed spaces, and universal precautions of safety for HCW and family members of TB patients may prove important steps in checking TB spread in India.

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TUBERCULOSIS AND AIR QUALITY

Dr. Jeff Glassroth
Feinberg School of Medicine,
Northwestern University, USA

Data on the relationship of air quality (AQ) with tuberculosis (TB) are limited but appear to be consistent and biologically plausible. Poor AQ has adverse effects on airway resistance, ciliary function and epithelial permeability. Poor AQ is also associated with a depressed immune response including an impaired macrophage function. Poor AQ, especially indoor air pollution (IAP), appears to be a modest risk factor for acquisition of tuberculous infection and progression to active TB. However, in areas where the prevalence of active TB is high and where biomass fuels are extensively utilized instead of cleaner fuels, the impact of IAP could contribute to thousands of cases of TB annually. Thus, it is estimated that 3% of cases of TB in India can be attributed to poor AQ. In a study on newly diagnosed cases of TB presenting as outpatients at St. John's Med College, Bangalore, it was reported that the absence of a separate kitchen in the house was strongly associated with risk of development of active TB [Odds ratio (OR) = 3.26; 95% Confidence intervals (CI)1.25-8.46]. On the other hand, higher education was found to be protective (OR = 0.30; 95% CI 0.11-0.82). In addition to exposure to biomass smoke, passive smoking which is an important cause of indoor air pollution, also remains a risk factor for developing active TB.

The exact mechanism(s) by which poor AQ exerts its effects is/are unknown . It is also not known what impact poor AQ has on treatment response or on the occurrence of relapse following treatment. Poor AQ relationship with drug resistant (MDR/XDR) TB also needs to be ascertained. It will also be helpful if the proportion of attributable cases that would be prevented with good AQ can be determined to help address the question of whether poor AQ actually helps cause disease or merely accelerates disease occurrence.

Even though AQ is a minor factor in comparison to mycobacterial virulence and host immunity, it may contribute to a large number of TB cases in high prevalence countries. Therefore, strong rationale exists for addressing both TB and AQ. TB and AQ (including passive smoking and IAP) are important areas for research and coordinated programs.

ROLE OF ENVIRONMENT AND RESPIRATORY INFECTIONS IN ASTHMA

Dr. Homer A. Boushey,
Professor, Pulmonary and Critical Care Division, Department of Medicine,
University of California School of Medicine,
San Francisco, California, USA

Strains of respiratory viruses differ in their pathogenicity. Genetic variations in strains of the same species cause great differences in the pathogen city. Inter-strain variations within rhinoviruses and corona-viruses are much greater than previously believed. Identification of most of the species is possible through the application of multiplex Polymerase Chain Reaction (PCR). PCR is highly sensitive for the detection of known viruses. Detection is restricted to the viruses homologous over the primer regions. Microarrays assays lead to broader sensitivity and can detect unknown viruses with incomplete homology to sequences laid down on the array (the "ViroChip"). PCR and "ViroChip" are comparably sensitive for the virus detection, and both are more so than the culture method. PCR is however, more rugged and readily applicable. Deep sequencing implies "Brute" sequencing of 50 oligo-nucleotides and thus provides a comparison to sequences of known viruses. Identification of genetic determinants of viral pathogenicity, however, requires advanced molecular virologic techniques.

The severity of illness caused by a constant strain of virus is a function of the effectiveness of host defense, which in turn is a function of the integrity of the airway epithelium, effectiveness of innate defense and effectiveness of Th1-related host defense. The integrity of the bronchial epithelium is in turn, affected by the inhaled allergens, the irritants and the pollutants. There is epidemiologic evidence to suggest that the bronchial epithelial damage is associated with a higher incidence of lower respiratory infections (LRI). Children of cigarette smokers have higher rates of hospitalization for bronchiolitis. Among asthmatic children, the severity of lower respiratory symptoms and the decline in peak flow correlate with nitrogen dioxide levels in the week before the onset of URI. Indoor air pollution from solid fuel use increases the risk for acute LRIs in children. Since there is no direct marker of bronchial integrity, the response to infection can be quantified by a questionnaire and by the conduct of studies which relate air quality data to the severity of illness from infection with the same species.

There are both physical and chemical innate mechanisms of epithelial defense. The physical defenses include the cell syncytium bound by tight junctions, the presence of mucus secretion and the ciliary clearance. The chemical mechanisms include the secretion of products like type-1 interferons, defensin B2 and B3 and cathelicidin that damage micro-organisms directly, or that activate other cellular mechanisms of defense like the toll-like receptors (TLRs).

The effectiveness of Th1-related host defense in infancy is a function of genetics, age and microbial exposure. Severity of viral infection is a function of Th1-mediated defense. Th1 cytokines are indispensable for effective cell-mediated immunity, necessary for eradication of intracellular pathogens, including the viruses. Infants who produce high levels of Th1 cytokines to infection have milder clinical course. But infants are normally born with a Th2 bias. The development of a robust cell- mediated immunity requires the production of Th1 cytokines. In infants at risk for development of atopy, Th2 polarization is more prominent and lasts until an older age and thus the development of Th1-mediated immune function is delayed. Understandably, both rickets and subclinical Vitamin D deficiency have been shown to be associated with a higher rate of severe LRIs in Indian children less than 5 years of age. Since the response to infection changes with the maturation of immune function, a correction for age is essential for studying the response to infection in infancy. The rate of maturation of immune function is affected by the microbial exposure in infancy, especially through the gastrointestinal tract. “Farm milk” ingestion in childhood is associated with lower rates of allergy and asthma. Feeding of probiotics, especially the *Lactobacillus* improves the duration of diarrhea due to rotavirus in children. New methods for characterizing the intestinal “microbiome” (the “PhyloChip”) are under development.

In epidemiologic studies, where the detection of respiratory viruses by PCR has been attempted in asthma exacerbations, rhinovirus has been identified in two-thirds of cases. It is estimated that rhinovirus infections are associated with asthma exacerbations in 50-60% of children and 30-40% of adults. No association has been found between the phylogenetic group of human rhinovirus (HRV) and the risk of asthma exacerbation. The symptom-questionnaire suggests that HRV A may cause more severe lower respiratory symptoms than the HRV B.

The long-term effects of RSV bronchiolitis in infancy in terms of subsequent risk of allergy and asthma in childhood are being studied. Severe RSV bronchiolitis in infancy requiring hospitalization was found to be a risk factor for subsequent asthma and allergic sensitization in one study. At one year of age, a significantly higher rate of asthma prevalence (11%) was seen compared to age and sex matched control subjects (0%). This increased prevalence of asthma was also higher in the RSV bronchiolitis group both at ages of 3 years (23% vs. 1%) and at 7½ years (23% vs. 2%) respectively. The combination of family history for asthma and severe RSV bronchiolitis gave the greatest risk for asthma in this population. The age at initial infection dictates the response to secondary RSV infection. Induction and maintenance of airway responsiveness to the viral infection is determined at the age of initial infection. Wheezing illness with rhinovirus is associated with a greater risk of childhood asthma than wheezing with RSV.

ENVIRONMENTAL AND CLIMATE-RELATED RISKS OF RESPIRATORY DISEASE

Dr. William Rom,

New York University, USA

Human health: Global warming and climate related changes constitute the major threat to human health and survival. There are several important and self-evident examples of such threats. The heat wave in France in August 2003 was one such example when the mean maximum temperature exceeded the seasonal norm by 11 – 12^{o}C on 9 consecutive days. There were 15,000 excess deaths between August 1-20, 2003. The mortality was age-related, in being higher above 45 years; 15% higher in women than in men. There was also an excess mortality at home and in retirement institutions than that in the hospitals. The mortality of the widowed, single and divorced subjects was greater than that of married people. This massive increase in deaths was related to heat-stroke, hyperthermia and dehydration. Death from cardiovascular, respiratory and nervous system diseases also markedly contributed to the mortality.

Increased CO_2 concentration from global warming increases ragweed pollen and risk of atopy, hay fever and asthma. The prevalence of chronic bronchitis in those that use biomass fuel (wood and cow dung) as the principal source of energy varies from 2.9 – 5% in India, to about 13 – 22% in Bolivia. Similarly, high prevalences of 8.1%, 10.0% and 18.3% were reported from Guatemala, Mozambique and Nepal. The particulate count ($\mu g/m^3$ per hour) were reported to be extremely high – 4400 in India and between 1200 – 13680 in Mozambique and Bolivia, against the EPA standard of 65 micrograms/hr.

Climate is closely related to vector-borne diseases especially malaria. Between 0.7 to 2.7 million people die of malaria per year of whom 75% are African children. It is theorized that the global warming will move the range of mosquitoes to the more temperate latitudes and high altitudes exposing more people to malaria risk. Increasing temperature shortens the incubation time of the malarial parasite inside the mosquito. *Plasmodium falciparum* has a threshold of $18^{o}C$ and *P. vivax* of $15^{o}C$. An increase of $0.5^{o}C$ in temperature can cause a 30 – 100% increase in mosquito abundance. East Africa's open treeless habitats or near crop have warmer midday temperature increasing *A. gambiae* per hour in these areas, and survivorship in pools of water. Pascual (PNAS 2005) correlated changes in temperature from 1950 – 2002 to mosquito-population dynamics showing biological variable order of magnitude greater than environmental.

Environmental effects of global warming

Global warming has an adverse effect on glaciers and permanent snowfields in mountains ranges through-out the world. The fear 'Is Greenland Melting?' (Nature, 17 April 2008) appears to be too true and the author has a first hand experience of the risk through his different excursions.

- T has increased $0.11^{o}C$.decade (compared with the global average of 0.06^{o}/decade) in the tropical Andes increasing melting of glaciers that supply drinking water to Quito, Lima and La Paz, and decreasing flows to hydroelectric plants.
- Global warming has been linked to the loss of 67% of the 110 species of Costa Rican, e.g. harlequin frog and golden toad due to pathogenic chytrid fungus due to shifting of its growth optimum. Extinction may engulf 15-37% of species by 2050 in mid-range climate warming scenario adversely affecting biodiversity. Global warming will make it more difficult to achieve biodiversity in National Parks.
- Wildfires: Borneo 1997 peat fires released 40% of global CO_2, 5.9M acres. Suharto started a Mega Rice Project that was abandoned but the canal system is draining the peat

bogs dry that then burn. Siberia 2003 forest fires released 250M tons CO_2, burning 48M acres.

- Amazonian deforestation in 2003 is 5.8 M acres/year (11 football fields per minute) due to roads, hydroelectric projects, forest burning and soybean farming.
- Damages from natural catastrophes have risen 50-fold since the 1970s brining a Swiss Re, Munich Re, and A.I.G., the largest U.S. insurer, ready to move capital into nonpolluting industries.

Increased occurrence of bleaching of coral reefs:

- Six periods of mass coral bleaching have occurred since 1979.
- In 1997-98, 16% of the world's reef building corals died due to EI Nino increase in sea surface temperatures.
- Impact of thermal stress on reefs can be due to ocean acidification pH 8.16 to 8.05 from carbonic acid due to increasing CO_2.
- Ocean acidity dissolves outer casings of coccolithopores, tiny plankton that form the basis of food webs.

Biomass and Hut-lung

- Asia, Africa, Latin America, indoor air pollution caused by burning biomass (branches, wood, dung, charcoal) and coal over primitive stones occurs in millions of homes. This is very inefficient burning.
- WHO estimates 1.6 M premature deaths/year from indoor air pollution (twice that from outdoor pollution). 9.8M by 2030.
- 3B people use biomass – 10% of global energy consumed. 80% of domestic energy consumption in India. 4^{th} in developing countries' burden of disease.

- Hut lung in women and pneumonia in children. High incidence of lung cancer in Chinese women.
- Chronic exposure to biomass smoke causes genetic damage, cardiovascular disease and stroke.
- Burning sugar cane also produces biomass smoke, e.g. Sao Paolo. Brazil reports 20% rise in respiratory disease in children and 30% increase in the elderly; 6.7 B tons of carbon by 2050 in Africa (cumulative); 6% of Africa's total.

(Medicine 2000; 79:310-7)

CHRONIC LUNG DISEASE IN CHILDREN: BRONCHITIS AND BRONCHIECTASIS IN NATIVE ALASKANS

Dr. Gregory J. Redding
University of Washington School of Medicine and Seattle Children's Hospital
Seattle, Washington, USA

Prevalence of chronic respiratory symptoms in Alaskan native school children is high (approximately 40%). Asthma is present in 13%, asthma with chronic productive cough in 7% and chronic productive cough alone in 19%. Childhood bronchiectasis, an important cause of childhood bronchiectasis, often starts with protracted bronchitis followed by chronic suppurative lung disease and finally radiologically over bronchiectasis. History of antecedent pneumonia and bronchiolitis is present in 70% and 17% respectively while 80% have history of lower respiratory infection (LRI) in the first year of life.

The most common clinical diagnoses among children hospitalized for a respiratory virus infection were bronchiolitis and/or pneumonia. Over 90% of children with RSV had one of these diagnoses. Children with influenza virus infection were more likely to have pneumonia while those with parainfluenza virus infection were more likely to have croup.

Hospitalization due to respiratory syncytial virus (RSV) infection was seen in almost 15% of infants. This rate was almost five times that of the general US population. Over the last decade, although the rate of RSV hospitalizations has decreased, that of non-RSV hospitalizations has increased and thus the overall respiratory hospitalization rate has not changed significantly. Moreover, children hospitalized for RSV infection when followed up have a higher incidence of chronic productive cough at the age of 6-7 years. Hyperinflation, atelectasis and presence of parenchymal densities are radiographic predictors of bronchiectasis in children less than 3 years of age.

Thus, these children have multiple LRIs prior to diagnoses of chronic bronchitis and bronchiectasis which are not related to any single virus. Those more predisposed to bronchiectasis have persistent or recurrent parenchymal densities, suggesting a sustained injury or poor repair. Factors that contribute to chronic bronchitis and bronchiectasis include 1) those predisposing to recurrent infections and 2) those aggravating viral-related airway injury. These latter factors include upper airway bacterial burden, dental caries, airway irritants, and possible aspiration. All of these factors contribute to increased secretion production and airway bacterial colonization with future pathogens. Interventions must be initiated early in life and even then may be only somewhat effective if initial airway injury is severe.

CLIMATE CHANGE AND HUMAN HEALTH

Dr. George Luber
Associate Director for Global Climate Change,
National Center for Environmental Health,
USA

The Intergovernmental Panel on Climate Change (IPCC) in 2007 has published landmark reports on the subject of climate change. There is an unequivocal evidence of global warming. Most of the warming of the past 50 years is very likely (90%) attributed to increases in greenhouse gases. The physical and biological systems on all continents and oceans are already affected by climate changes. The next few decades are likely to witness more warming. The effects of emissions in the long term are already becoming more and more evident.

The worldwide effects of global warming are apparent from the evidence of global destabilization of natural systems. Some of these effects include the melting of ice-caps and glaciers, early arrival of spring, warming of oceans, rising sea levels, occurrence of extreme weather patterns and the disintegration of coral reefs. Some projections of future changes in climate as per the IPCC 2007 are as follows:

- Very likely that heat waves will become more intense and frequent. [> 90% probability]
- Very likely that heavy precipitation events will become more frequent. [> 90% probability]
- Likely that tropical cyclones will become more intense, with larger peak wind speeds and more heavy rainfall [> 66% probability].
- Likely increase in areas affected by drought [> 66% probability].
- Likely increase in incidence of extremely high sea level [> 66% probability].

An important consideration is that there will be significant regional variations in the effects of climate change and in the demographic groups which are affected. Some of the occurrences in the near future will be well beyond the past historical experiences.

Added to the climate change-driven increases in temperature are the additional effects of the urban "built" environment. In fact, the cities and the climate are co-evolving in a manner that will certainly amplify both the effect of heat as well as the vulnerability of urban populations to heat-related deaths. For example, more than half the planet now lives in cities, up from 30% only 50 years ago. Urban areas are gaining an estimated 67 million people per year—about 1.3 million every week. By 2030, approximately 60% of the projected global population of 8.3 billion will live in the cities. Additionally, there is a projected increase of 100 million more persons of greater than 65 years of age by the year 2100. This population-increase will be accompanied with rapid urbanization which is quickly transitioning communities from native vegetation to an engineered infrastructure that increases thermal-storage capacity, resulting in significant changes in the urban climate compared to the adjacent rural regions, known as the Urban Heat Island Effect (UHI). The UHI can be a powerful force in the local climate. The combined effect of the high thermal mass provided by concrete and blacktop roads, and the low ventilation ability of the urban "canyons" created by tall buildings serve to extend the temperature increases created by climate change. In real terms, relative to the surrounding rural areas, urban heat islands can add from 7-12°F to the urban heat load. More importantly, the UHI serves to absorb heat during the day-time and radiate it out at night, raising the night-time minimum temperatures, which have been epidemiologically linked with excess mortality.

Starting with heat waves, the media attention on climate change tends to focus on gradual changes in temperature. However, the extremes of temperature and the climate impact the people more than the mean and in greater numbers. According to the most recent studies, heat waves are projected to increase in frequency and in duration. For example, in May of 1988 and 2003, heat waves killed over 4,000 people in India through heat stroke, exacerbated cardiovascular, cerebrovascular, and respiratory diseases. A large portion of these deaths had occurred amongst the children, the elderly, and the agricultural workers, who represented the most susceptible populations to extreme heat.

The UHI and CO_2 Dome will also have an impact on urban aeroallergens. Increased CO_2 levels and temperature will lead to an increase in the ragweed and pollen counts due to a longer growing season. Forest fires also present a major threat to the air quality in rural areas, since the climate change affects the hydrologic cycle and causes drier conditions. Young children, pregnant women, the elderly, and the people with preexisting respiratory and cardiac diseases are the most affected by the health impacts of smoke.

The increased frequency of more intense rainfall (extreme precipitation events) is associated with an increasing severity of floods, landslides, debris and mud flows. This has already been witnessed in parts of Bangladesh, Nepal and India. Increases in sea surface temperature (SST) have caused an increase in tropical cyclone intensity leading to an increase in the height of the storm surges. Large populations live along South Asia's coast, and will face the brunt of increasing tropical cyclones.

Increasing temperatures are also likely to impact the prevalence of agricultural pests. Climate impacts on agriculture are expected to be acute in South Asia. Pests which affect agricultural production are expected to increase in frequency with increase in droughts and floods. This will severely affect the food availability in areas of South Asia, one of two "hunger hotspots" of the world where food security is of greatest concern. Droughts encourage the growth of aphids, locusts, whiteflies and *Aspergillus flavus* (fungi) while floods encourage the growth of molds, other fungi and nematodes.

Within the mountainous regions of South Asia, there is a large potential for glacial lake outburst floods to occur. A Glacial Lake Outburst Flood (GLOF) is a flood that is created by a receding glacier and its accumulated melt water. Large pieces of melting glaciers may fall into the water as water accumulates at the basin, sending massive waves which break the existing moraine, releasing large amounts of water, rocks and debris into the lower lying areas. GLOFs can thus cause catastrophic downstream flooding and extensive infrastructure damage following the release of large amounts of water. Increasing temperature changes have caused an increase in glacial melting and GLOFs. In Bhutan, an assessment has shown 24 glacial lakes that are considered potentially dangerous, and a major GLOF is predicted to occur by 2010 (WHO, 2005).

Cholera outbreaks are associated with insufficient sanitation, but evidence shows that climate also plays in the variability of disease. Changes in SST and increased nutrient availability have allowed phytoplankton to grow, which provides excellent habitat for the survival of vibrio cholera. Evidence also shows that El Nino plays an important role in the inter-annual variability of endemic cholera. In Bangladesh, cholera cases peak twice, once in the spring with a large peak and another in the monsoon season. These epidemics are correlated with dry weather and warm water temperatures.

The breadth of potential health consequences of climate change range from the direct effects of temperature increases such as the heat waves and the severe weather events to the secondary effects, such as the population displacement, civil conflict and mental health issues.

Strategies to minimize the health-related burden of climate change in South Asia need to focus on improving responses to many ongoing issues that will occur with greater frequency, intensity, and geographic range. Country specific strategies are needed since each country within a region has specific vulnerabilities to climate change health effects. Regional collaboration and integration would help to maximize resources. All strategies will need to improve surveillance of environmental and health data systems that are already in place. It is necessary to assess these needs and retool public health care services so that they provide effective responses. Higher level issues such as migration and civil conflict have challenged or slowed development of the health sector, thus, climate change activities will have to be prioritized in this context in addition to the ongoing development of other non-health sectors. Another important principle is the concept of co-benefits, or synergies between mitigation and adaptation. Climate change mitigation programs provide opportunities both to reduce the green house gas emissions and to benefit health at the same time.

In conclusion, the climate change is now a mainstream issue and must also be framed as a public health concern. The costs of not taking appropriate and timely action are rather high.

IMPACT OF TOBACCO USE ON RESPIRATORY DISEASE IN INDIA

Dr. S. K. Jindal,
Professor & Head,
Department of Pulmonary Medicine,
Postgraduate Institute of Medical Education & Research (PGIMER),
Chandigarh, India

Tobacco usage in India is common in both the smoking and the non-smoking forms. Non-smoking tobacco is mostly consumed via the oral route and/or other applications. Some of the common forms of tobacco use are listed as under:

Smoking Forms	**Non smoking Forms**
Bidis	Betel quid (Paan)
Cigarettes	Gudhaku (Paste)
Cigars	Paan masaala
Cheroots	Creamy snuff
Chutta (Reverse)	Mainpuri
Dhumti (Reverse)	Tobacco water (Tuibur, Hidakphi)
Hookas and Hooklis	Mawa
Pipe	Khaini
Chillums	Chewing tobacco
	Snus, Mishri, Gul and Bajjar

In addition, non tobacco products like Nirdosh and Vardaan are also smoked. Bidi (34%) and cigarette (23%) smoking constitute the most common form of consumption of tobacco leaf in India. Hookah smoking (5%) and chewing (9%) are the other important forms. "Reverse" smoking, where the lighted end is kept inside the mouth is common in the coastal areas of Andhra Pradesh and Orissa; and is associated with a higher incidence of leukoplakia and oro-pharyngeal carcinoma.

Overall, a higher tobacco use is seen among men (57% vs. 11% for females) and in rural areas (6-11% higher than urban areas). More than two-thirds of men in the 11 states use tobacco. The Global Youth Tobacco Survey (GYTS) conducted jointly by the Government of India

(GOI), the Centre for Disease Control and Prevention (CDC) and the World Health Organization (WHO) studied the prevalence of tobacco use among students (13-15 years of age) revealed that the current usage of tobacco in any form was approximately 17.5 %; the use of smokeless forms was higher (14.6 % vs. 8.3% for smoking forms). There were no significant urban-rural differences. The ever use of tobacco was higher for boys (20% vs. 10% in girls).

Several initiatives have been taken in the field of smoking and lung disease at this Institute (PGIMER) over the past three decades. These include collaborations with the GOI, Indian Council of Medical Research (ICMR), WHO and the CDC and to conduct studies such as the GYTS, formulation of guidelines for COPD and asthma at the primary care level and the multicentre epidemiology studies. At present, phase II of INSEARCH (Indian Study on Epidemiology of Asthma, Respiratory symptoms and Chronic bronchitis) is being undertaken at 12 centers throughout India. The phase I study as 4 centers was completed earlier in the year 2005. This is a population based study with a uniform methodology, standardized/validated questionnaire and central analysis (both centre-wise and pooled). The objectives of INSEARCH are to study the epidemiology of asthma, other atopies, men specific respiratory symptoms and chronic bronchitis in different parts of India; to assess the national median/mean prevalence and disease burden, as well as to assess the role of risk factors smoking, environmental tobacco smoke (ETS) exposure and indoor air pollution.

In the phase 1 of this study with a sample size of 73605, the overall prevalence of tobacco smoking was 15.6%. Bidi smoking was the most common (69.3%) form while cigarette smoking was seen in 26.6%. Respiratory risks observed with tobacco smoking included a higher prevalence of respiratory symptoms, lung function impairment and COPD, a higher annual decline of FEV_1 and higher death rates from COPD. Both bidi and hookah smoking were associated with higher odds of having chronic bronchitis in comparison to cigarette smoking. Environmental tobacco smoke (ETS) exposure and solid-fuel combustion were found as important causes of environment (indoor) pollution, as well as of COPD, in both non-smoker and smoker individuals. Crowding at homes/offices and poor ventilation played an important role in this context. ETS exposure among non-smokers was commonly observed in women, young individuals, residents of rural areas, and of lower socioeconomic groups. This exposure most commonly was from parents and husbands.

Prior to this study, other population studies done in India over the past 30 years have shown a median prevalence of COPD as around 5.0% (range of 1.9-9.4%) in males and 2.7% (range 1.2-4.9%) in females, with a male: female ratio ranging from 1.3-2.6. Tobacco smoking in the form of cigarettes, ‘bidis’ and other indigenous products was responsible for over 82 percent of COPD burden. In terms of economic burden, the annual cost of management of COPD approximated almost one-third of the average income of a patient. Families with one (or more) smoker members had significantly higher health related expenditure, higher work and school absenteeism and a greater number of illnesses.

It can be concluded that COPD with a prevalence of over 4% in the adult population of India has emerged as a major cause of health-care burden. In addition to COPD, smoking and ETS exposure are also important in the etiology of asthma and for worsening of disease-control in asthma, in both children and adults. Odds of having bronchial asthma are highest for hookah smokers followed by bidi and cigarette smokers. Smoking (and possibly ETS exposure) are also responsible for increased morbidity and mortality from pulmonary tuberculosis.

OCCUPATIONAL RESPIRATORY DISEASE: EMERGING ISSUES

Dr. James E. Lockey
Departments of Environmental Health & Pulmonary Medicine
University of Cincinnati College of Medicine, USA

There are several different issues of importance related to occupational respiratory diseases. Some of the new emerging issues concern low level mineral fibre exposure and pleural disease, food flavourings and airway obstruction, and nanotechnology.

1. Low level mineral fibre exposure

Exposure to vermiculite containing asbestiform amphibole fibres is associated with an increased prevalence of pleural changes at a low cumulative working lifetime fibre exposure (CFE) of <1 fibre/cc-year. This is below the lifetime CFE for a worker exposed to the current US Occupational Safety & Health Administration (OSHA) standard of 0.1 fibre/cc for regulated commercial asbestos over a 45-year working life (4.5 fibre/cc-years). The potential future public health implications are reflected by the example of an increased rate of malignant mesothelioma in Libby, Montana residents with no history of occupational exposure to vermiculite or commercial asbestos. The US Mine Safety and Health Administration has listed over 150 minerals that may occur in fibrous forms or that are generally expected to contain fibrous minerals.

2. Food flavoring

A food flavor is a complex mixture of individual flavoring substances that have been ‘compounded’ to provide the desired taste. Over 2000 individual single chemically defined substances are used by manufacturers to formulate flavors. Diacetyl is an example of a water soluble volatile di-ketone butter flavoring that is a constituent in numerous foods. The flavor manufacturing industry produces concentrated diacetyl formulations for use in the food production industry including microwave popcorn. Obstructive lung disease including bronchiolitis obliterans has recently been associated with microwave popcorn manufacturing. Subsequent animal studies have confirmed the ability of butter flavorings or diacetyl to injury the airway. The vast majority of food flavorings, however, have not been evaluated in regard to potential pulmonary toxicity and remain un-regulated from an occupational exposure perspective.

3. Nanotechnology

Nanotechnology involves the manipulation of nanoparticles (≤100 μm) and nanomaterials. Nanomaterials come in various sizes, configurations and chemical composition and this emerging field is forecasted to have a significant global economic impact by the year 2015. Animal and *in-vitro* studies have shown nanoparticles to be associated with pulmonary inflammation, oxidative stress, distal organ involvement, inflammatory cytokine production, and cell death (apoptosis). The important unresolved and emerging issues are related to the potential for increased human dose via inhalation, gastrointestinal absorption and skin penetration. The nanotechnology field is evolving rapidly and hopefully, the nanotoxicology field with appropriate exposure control measures will keep pace.

COMMUNITY-BASED PARTICIPATORY APPROACHES: DEVELOPMENT OF INTERVENTIONAL APPROACHES TO STUDYING IMPACT OF ENVIRONMENTAL RISK OF HOUSEHOLD ENERGY

Dr. Nigel Bruce
University of Liverpool,
United Kingdom

In this discussion of community-based and participatory approaches to household energy development, we will consider three inter-related issues. First, what these can offer and their place in the context of national policies on environment, health and development; second, the opportunities community-based approaches offer for research, together with the constraints, particularly in respect of assessing health outcomes; and third, the factors can help translate research findings into benefits for the those taking part in studies, and for the community in general.

Community approach, particularly with a strong participatory component, can offer input from different cultural perspectives, and can successfully engage with the community's needs and ideas, thereby leading to more appropriate interventions and greater commitment and sustainability – although this outcome is by no means guaranteed. An over-riding goal of interventions and policies is that these should aim at being effective, sustainable and equitable. Specifically, these should reduce indoor air pollution (IAP) exposure, leading to respiratory and other health benefits which include child pneumonia and chronic obstructive lung disease (COLD) in adults, lung cancer (where coal is used), and potentially reductions in a number of other health outcomes such as TB – although the evidence for this is currently less clear cut. Improvements in stoves can also benefit health through greater safety, for example by preventing burns to children and women, while fuel-costs and time-savings can lead to both economic development and environmental benefits.

Among the key priorities for research on household energy are (i) to extend our knowledge about the health impacts of IAP and the underlying mechanisms; (ii) to strengthen the evidence available for guiding policy by quantifying health risks, estimating burden of disease, and describing a range of other social, environment and economic benefits, and (iii) evaluating policy to identify approaches that offer the most efficient means of delivering interventions and how these should be financed.

In this discussion, we consider what community-based approaches to developing and delivering household energy interventions have to offer, how these can contribute to the achievement of priority research goals, and where the opportunities and limitations lie. A useful starting point is to compare and contrast approaches promulgated through community development and those planned and delivered at a much larger scale including at the national level, summarized in Table 1 (below):

Table 1: Comparison of community development and large scale/national approaches to delivery of household energy development programmes

	Community development	**National, large scale approaches**
Main actors	Non government organizations (NGOs), Community based organizations (CBOs) and artisans	Government, large private sector companies and organisations
Advantages	Identifies needs and locally appropriate interventions	Can fit with national strategy and policy
	Involves and motivates community members, especially women	Easier to engage larger private sector partners
	May provide more opportunity to include poorest households	May involve economies of scale and improved quality through mass production
Limitations	Products may not be transferable	May be less appropriate to local needs, although markets can work well for those able to pay
	If small scale, has limited coverage	Acceptance may be more patchy, especially for the poor
	Approach may fail when scaled up	

Community-based household energy development programmes should involve some degree of active community participation, although this can vary from consultation to more empowering participation. The size of these initiatives is variable, some being quite large, but historically community engagement has not been the approach taken for most large-scale and national level programmes. Table 1 illustrates the ways in which community-based approaches complement larger scale and national led-programmes. A challenge, however, has been how to scale up the benefits of local relevance and engagement achieved through community involvement without diluting or losing these advantages altogether.

A key principle for gaining input from any given community, and responding to their needs and cultural norms, is through the building of trust. This also helps to motivate the community members to contribute their ideas and efforts. It is essential to use the 'language' and concepts with which the community feels comfortable. Technology development should be carried out in partnership with the community, including both women and men, and should respond to the feedback they provide, especially in the early stages of a programme. It is very important for future acceptance and success that participants see that their input is actually contributing, by shaping interventions and programmes available to their communities.

Drawing on one example implemented by an international NGO Practical Action and the UK DFID in Sudan, Kenya and Nepal, community-based projects may have two (or more) phases. For example, an initial phase that is aimed at developing intervention technology options and ensuring these are accepted and effective, and a follow up phase in which the project is scaled up and the interventions and approach to implementation and financing additionally assessed for sustainability and economic efficiency. This latter phase would also involve market surveys, promotion of the intervention(s), training and support of artisans involved in production and/or services for maintenance, fuel supply, etc., and for revolving funds or other forms of low-cost finance. Monitoring of the growth of the project and evaluation of its impacts is important and we will now look at the opportunities such approaches offer for research.

Interventions Research: Intervention programmes can provide opportunities for carrying out research on all three priority areas described above. Opportunities and constraints will depend on many factors, but one key issue is whether the research is designed around the adoption of intervention following a community development process, or whether the interventions have been provided to households primarily to meet the requirements of a specific research design, for example a RCT Table 2 (below) summarises the main areas of opportunity and constraint in carrying out research in the context of evolving community-based intervention programmes, as compared with those in which the intervention is implemented to meet specified research goals:

Table 2: Opportunities for and constraints on research in community-based household energy interventions

Opportunities	**Constraints**
Involvement of the community facilitates understanding by the research team of how and why interventions are used (or, quite frequently, not used as expected)	If the programme is small scale, numbers may give insufficient statistical power for health outcome studies
Insight from this involvement facilitates understanding of reasons for exposure reductions achieved, (and therefore, expected health benefits)	The timing of intervention uptake is often unpredictable in place and time, making it difficult to plan robust study designs and the associated logistics – particularly for health outcomes.
Where the intervention is being adopted by a community, there is the opportunity to study the effectiveness and efficiency of intervention use more realistically than where the intervention is donated for the purpose of research.	NGOs may not accept studying comparison groups where this involves witholding interventions for a substantial time period.
A strong trust relationship may elicit more honest information in responses to interview questions, etc., and greater acceptance of procedures such as IAP and exposure measurement. This may not always be the case, however – see opposite	If there is a close relationship with the NGO or other organisation which, in eyes of the study respondents has been responsible for the development process, there may be a tendency on the part of respondents to want to please by being overly positive about outcomes, and/or repeating back promotional messages.
Links with a community can facilitate translation of research findings into practice, particularly if community members have been involved in the research process.	There is the potential for added complexity in development, research and funding arrangements

The full range of epidemiological study designs are available (and have been used) for studying the impact of cleaner and more efficient household energy interventions on health. Qualitative research methods also have an important role to play in providing insight into the context of household energy use, and other important considerations include gender-related issues, and reasons why alternative technologies and fuels may or may not be adopted. Qualitative methods will not be further discussed here, but their contribution should be carefully considered when during the planning of research studies.

As noted above, there have been to date broadly two approaches to studying the effects of interventions. In the first approach, developing and promoting the community-based intervention is the main purpose of the work (by, for example, an NGO), and the evaluation study is then built around this activity. In the second approach, the primary goal is to obtain scientifically robust data on impacts including health, and the provision and allocation of the intervention is determined by the demands of study design rather than the development process. While the first approach potentially allows evaluation of the intervention in a more realistic, programmatic scenario, this does present more challenges for study design (e.g. obtaining valid comparison between intervention and control households) and logistics (e.g. planning research activity in situations where the rate and location of adoption is not easily predicted).

Intervention-based designs include quasi-experimental (before and after comparisons, and those with parallel comparison groups), and experimental studies (individual or cluster randomised controlled trials). One further design, the ‘step-wedge’ relies on progressive diffusion of the intervention across a community to provide comparison between those areas receiving the intervention earlier in the programme with those initially serving as controls in other areas who receive the intervention later. Observational analytic designs, that is case-control and cohort, may also be carried out in communities where interventions are being adopted, and (depending how it is diffused) the presence of an effective intervention may help to ensure (i) a wider range of exposure and (ii) greater homogeneity of confounding factors, than might otherwise be found.

Community-based intervention programmes have generally been studied using quasi-experimental designs. This partly reflects the often quite limited resources available for such studies, but is also overwhelmingly determined by the inherent incompatibility between the requirements for randomised allocation in an experimental study and the process of development associated with community programmes, including community-wide awareness raising and promotion, market development, and other components that complicate the management and maintenance of intervention and control groups. Cluster randomised trials may offer the best compromise if the development work can be promoted and delivered within well-defined clusters – for example villages in a setting whether these tend to be distinct and relatively self-contained.

Quasi experimental designs, particularly simple before and after comparisons, need to be planned and interpreted with care due to the potential for confounding. Wherever possible, comparison groups should be included, and matched as closely as possible to intervention homes. Development organisations such as NGOs may find it difficult to accept the inclusion of comparison groups that are studied but not assisted, especially if the follow-up period is as long as a year or more, but the importance of having a comparison group means that a strong case should be made for this at the project planning stage. Internal comparison may also be possible within a simple before and after design where, for example, individual exposure to IAP is measured along with individual outcomes, including health. Thus, some additional analytic strength can be gained by studying the impact of individual change in exposure and individual change in the outcome, the comparison being provided by the different levels of exposure change experienced by the different households that make up the study. As comparison is being made of within-subject changes, fixed person-specific characteristics such as age, sex and type of house, etc., are controlled for.

In summary, intervention study design will be strongly influenced by the way in which an intervention is being delivered and promoted within a community, if the intention is to examine the health and other impacts of programmes that are attempting to promote uptake through sustainable awareness raising and market development. It will be very valuable to obtain robust scientific evidence on the effects of such programmes on critical health outcomes such as childhood pneumonia. In order to achieve this, it will be important to design intervention studies which have well-matched comparison groups if some form of randomisation is not feasible.

Translation of research findings into practice: The third objective of this discussion is to consider how best to translate research findings into tangible benefit, in particular for those communities where research has been conducted.

In general, it can be expected that this will be easier to achieve where a community-based approach taken, particularly where this has involved a wide range of partners and has established markets and financing mechanisms to assist poorer households.

The ways in which the research work can assist the community will depend on what research findings are available. Thus, findings on the reductions in IAP and performance of the stove (for example, fuel efficiency) may inform changes in stove design, while findings on the most effective and efficient means of promoting the uptake of interventions would inform the approach taken to disseminating and financing stoves and other interventions. Evidence on the impacts on health and wellbeing would be used to promote awareness, and engage the health sector.

In terms of ensuring that research evidence does benefit communities, whether these are the actual communities in which the research has been conducted or the wider populations to whom it is intended that the research should also refer, there needs to be engagement with all sectors with a part to play, and at all levels in society. Research evidence needs to inform action at all levels, from that of the individual and household, through community, local government, private sector, national government and international organisations such as WHO, UNDP, and donors. In addition to ensuring that the evidence on impacts of interventions (IAP reduction, health impacts, fuel and time saving, etc.) together with experience on the most efficient approaches to promoting adoption are compiled and available to inform decision-making at all levels, it is also important to stimulate and support action in countries. The key elements of this support are shown in Box 1.

Box 1: Key elements of support for action on household energy development in countries

- Tools for needs assessment, including survey instruments, IAP assessment, and guidance on the application of qualitative methods
- Guidance on identification of key partners and their roles, and how collaborative action can be encouraged and maintained
- Assessment of intervention options, including what is available and how alternatives can be developed and evaluated
- Approaches to awareness raising, generation of demand and market development
- Guidance and support on monitoring and evaluation

In conclusion, community-based approaches to the development and implementation of improved household energy options for the poor offer the potential for relevance, engagement and sustainability, but it is important to see this contribution within a national context of policy on a wide range of issues that can help to increase access to clean and efficient household energy including taxation, energy supply and distribution, education, health land reform, gender issues, forestry management and others. Community-based approaches also offer important opportunities for research, particularly where there are opportunities to study the experience of users and impacts on IAP, fuel use and time as interventions are adopted through the establishment of sustainable markets for improved technology and fuels. On the other hand, this approach to adoption presents considerable study design challenges for measuring the impact on critical health outcomes such as child pneumonia, low birth weight and COPD. A priority for health research is to find opportunities to conduct robust, large scale studies on the impact of sustainable household energy programmes on outcomes such as pneumonia, including pneumonia mortality. The engagement that is an integral part of community-based interventions should help with translating research findings into real benefit for the communities concerned, but action at all levels in society needs to be encouraged and supported.

ASTHMA AND ALLERGIES IN CHILDREN: CHANDIGARH EXPERIENCE

Dr Meenu Singh
Department of Pediatrics, PGIMER, Chandigarh, India

A worldwide increase in the prevalence of asthma has been reported in recent years. With an increase in prevalence comes an increased burden of disease in terms of morbidity, mortality and compromised quality of life (1). It is estimated that as many as 300 million people of all ages and all ethnic backgrounds suffer from asthma and the burden of this disease to governments, healthcare systems, families and patients is increasing worldwide.

With the projected increase in the urban proportion of the world's population from 45% to 59% in 2025, there is likely to be a marked increase in the number of individuals with asthma worldwide. It is estimated that there may be an additional 100 million people with asthma by 2025. The South Asian region of the world, with several developing countries, abounds in people with asthma who do not have access to basic asthma medications or medical care. Particular resources need to be provided to improve the care of disadvantaged groups with high morbidity, including certain racial groups, those who are poorly educated, live in large cities or are poor. Resources also need to be provided to address preventable factors that trigger exacerbations of asthma, such as air pollution.

The prevalence of asthma symptoms has been assessed by the International Study of Asthma and Allergies in Childhood (ISAAC) in several Asian countries using a standardized questionnaire. The results of the ISSAC study suggest substantial worldwide variations in the prevalence of symptoms of allergic rhino conjunctivitis, asthma and atopic eczema. The ISSAC study noted a significant variation in prevalence in different parts of India with range 0.5%-18%

in 12- month prevalence of self reported asthma symptoms from written questionnaires. A 20 to 60 fold difference in the prevalence of symptoms was found between various centers involved in this study. Although prevalence data of allergic diseases in India is scarce, the little data that are available suggest that patterns differ in different areas. A study of 271 children from rural areas of Tamil Nadu reported a prevalence of breathing difficulty at any time in the past of 9%. In another study in rural areas of North India, the prevalence of chronic cough among children aged 1-15 years (n=2275) was 1.06% and two thirds were due to asthma. Such variable patterns also exist across urban regions. Prevalence rates ranging from 1.9% to 15.7% have been reported. Such national variation with almost 10-15 fold difference in the prevalence of allergic disorders is probably unique to India.

Another study conducted at our centre under the aegis of the asthma Task Force of the Indian Council of Medical Research, a survey was conducted on 10,028 schoolchildren (10-15 years of age) belonging to 39 randomly selected schools for the diagnosis of asthma and other atopic diseases in Chandigarh, India. A total of 536 children were found to have a current clinical diagnosis of asthma, allergic rhinitis or eczema. The prevalence of asthma was 3.3%. These findings were similar to the ISSAC surveys conducted at our centre.

Efforts have been made not to under diagnose as well as to prevent wrong diagnosis of this disease. Viewing this, Consensus Guidelines were framed on childhood asthma in India for the first time using published and appraised evidence in 1999.These were followed by Nationwide dissemination by a module Asthma by consensus by the Indian Academy of Pediatrics (2,3).

Most urban areas in South Asia have high pollution indices, characterized by narrow streets, heavy traffic, smog, unplanned city architecture and the use of kerosene or wood as household fuel. However some areas are clean and modern, with concrete housing, vehicle emission regulations and the use of smoke free household fuel. A study was conducted to compare the prevalence of wheeze in 13-14 year olds between two south Asian cities (Galle, Sri Lanka and Chandigarh, India) representing each of the above archetypes. The prevalence rate for wheezing in Galle (28.7%) was higher than that in Chandigarh (12.5%). Hence a higher prevalence of wheeze was noticed in 13-14 years old children living in an old fashioned, congested city than in a clean and modern city in south Asia (4). One of our birth cohort study on hygiene hypothesis (results yet to be published) was carried and in line with other studies and we have found an apparent protective effect of sib ship sizes where as risk is increased if the neonate has a family history of allergy, particularly maternal allergy.

Asthma is known to reduce the quality of life of its sufferers. Most studies relating to quality of life come from the developed world. Appropriate measures to estimate quality of life in developing countries with diverse cultural beliefs, values and convictions are practically non-existent. Some attempts have been made in this direction but the wider applicability of these measures needs to be validated (5,6).

Inhaled corticosteroid therapy (ICT) proves to be promising in improving the quality of life in asthmatic individuals as per evidence based guidelines (7). Basing decisions on evidence gathered by effective appraisal of literature as done in the Cochrane Library. Cochrane library is an electronic database which emphasize limitation of systematic reviews (which are establish where the effects of health care are consistent and research results can be applied across populations and settings) and random error, and providing more reliable result upon which to draw conclusions and make decisions (3, 8, 9).

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