The effects of $PM_{2.5}$ on health of children in Dhaka, Islamabad and Kathmandu

Assoc. Professor Frank Murray
Murdoch University
Perth, Australia

Seventh Regional Stakeholders cum Coordination Meeting (RSC7), 18-19 May 2013

Presentation based on the following reports

- NIPSOM and Department of Environment 2008. Final Report: Assessment of Impact of Air Pollution among School Children in Selected Schools of Dhaka City, Bangladesh. National Institute of Preventive and Social Medicine and Department of Environment, Dhaka, Bangladesh.
- PakEPA and PMRC 2013. Final Report: Impacts of Particulate Air Pollution on the Respiratory Health of Schoolchildren in Pakistan. Pakistan Environmental Protection Agency, and Pakistan Medical Research Council, Islamabad, Pakistan.
- NHRC and ICIMOD 2013, Assessment of Impacts of Particulate Air Pollutants on Respiratory Health of School Children in Kathmandu Valley. Nepal Health Research Council and International Center for Integrated Mountain Development, Kathmandu, Nepal.

Project

What are the effects of air pollution on health of children in large cities in South Asia?

If actions are taken to reduce air pollution, what will be the health benefits?

The project aimed to test the relationship in school children between:

- Daily particle concentrations measured in Dhaka, Islamabad and Kathmandu

and

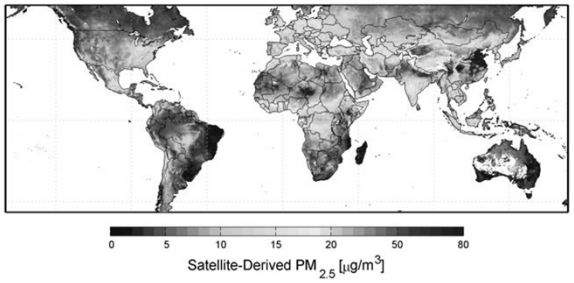
- Peak expiratory flow (as an indicator of lung function)

How high are PM levels in Dhaka, Islamabad and Kathmandu?

Concentrations of $PM_{2.5}$ during these studies in Dhaka, Islamabad and Kathmandu (NHRC & ICIMOD, 2013; NIPSOM & Department of Environment 2008; PakEPA & PMRC 2013)

Concentrations of $PM_{2.5}$ (in µg/m³)	Dhaka	Islamabad	Kathmandu Urban school	Kathmandu Semi-urban school
Mean concentration	67	81	203	137
Maximum concentration	233	142	337	231
Minimum concentration	18	25	102	76
Air quality national standard	65	40	40	40

Comparison of $PM_{2.5}$ around the world (soil dust and emissions)



Global satellite-derived map of $PM_{2.5}$ averaged over 2001-2006. Credit: Dalhousie University, Aaron van Donkelaa

Regional Particles in Air

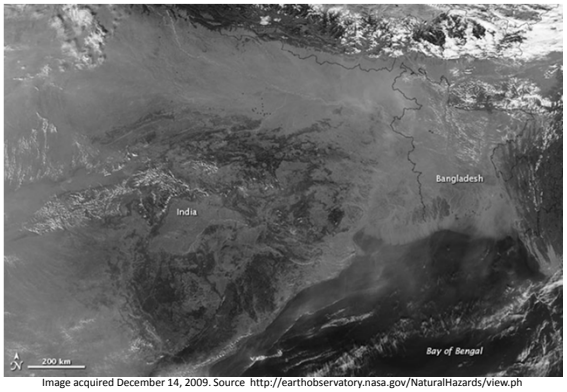


Image acquired December 14, 2009. Source http://earthobservatory.nasa.gov/NaturalHazards/view.ph

Two Phases

- The studies had two components: Phase 1: a baseline survey and Phase 2: a health impact assessment.
- The baseline survey used a structured questionnaire developed for international use by the International Study of Asthma and Allergies in Childhood.
- The baseline surveys were conducted based on 1618 children in Dhaka, 801 children in Kathmandu and 328 children in Islamabad.

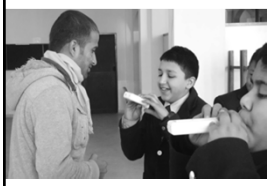
Results of the Phase 1 questionnaire

- These studies in Dhaka, Kathmandu and Islamabad showed a high level of respiratory illnesses not associated with colds or flu.
- Nearly 30% of children had respiratory symptoms such as sneezing, running nose or nasal blockage without common cold or flu.
- About 25% of them had symptoms that hampered their studies and activities.
- About 30% of all children with respiratory health issues visited a doctor or other health facility.
- Due to these respiratory health issues in Kathmandu 43% of the children missed school for one or two days, 42 % of their guardians missed their work due to these illnesses in children

Phase 2

- Phase 2 assessed the impact on respiratory health of fine particles in air ($PM_{2.5}$), among 180 children in Dhaka, 137 children in Kathmandu and 132 children in Islamabad.
- Children of age between 9-16 years in Dhaka, 10-15 years in Kathmandu and 9-14 years in Islamabad were assessed for their lung function by measuring morning peak expiratory flow rate (PEFR).

Phase 2



- Measurements of $PM_{2.5}$ were recorded daily in in Dhaka and Kathmandu and weekly in Islamabad. Weather data were also recorded.
- PEFR and $PM_{2.5}$ measurements were conducted for 35 days in Dhaka, 31 days in Kathmandu and a total of six weeks in Islamabad.

$PM_{2.5}$ in Dhaka

The daily mean concentrations of $PM_{2.5}$ varied from 18 to 233 µg/m^3 with a mean of 67 µg/m^3. It exceeded the Bangladesh daily $PM_{2.5}$ standard of 65 µg/m^3 on 13 of the 42 days of health data collection.

Major findings of the Dhaka study

The results in Dhaka show that there is a relationship between Peak Expiratory Flow Rate a measure of lung function, in both asthmatic and non-asthmatic children and $PM_{2.5}$ concentrations.

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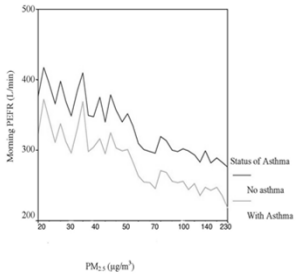
PEFR decreased when $PM_{2.5}$ increased



PEFR in Dhaka decreased by about 30% in both asthmatic and non-asthmatic children when $PM_{2.5}$ increased from its lowest level of 18 µg/m³ to its highest daily mean of 233 µg/m³

Comparison with adult female smokers and non-smokers - only 16% reduction

	PEFR L/min	
Non-smokers	Range Mean	330-340 332
Heavy smokers	Range Mean	270-300 280

Both groups were 100 women, 30-40 years old of similar height and weight from Nepal

Source: Prasad et al, 2003

Additional expenditure

- Total annual expenditure for respiratory illnesses of asthmatic children (6918 Taka, about 100 USD) was twice that of non-asthmatic children.
- Of about 2.37 million children of school age in Dhaka, 25.8% have clinical symptoms of asthma, about 0.61 million children.
- The additional expenditure on respiratory illnesses for children with asthma in Dhaka is about USD 30 million per year.

The results are consistent with other studies

- The finding that increases in $PM_{2.5}$ levels are associated with impaired lung function in children with and without asthma is in agreement with studies in Mexico City, the Netherlands, Bangkok and studies in the USA
- The severity of the changes in PEFR with increases in PM is an important new finding

Impacts on children with asthma

Although data from Dhaka are not readily available, based on data from the USA and assuming the same health outcome ratios apply to Dhaka, the 0.61 million children in Dhaka with asthma will have

- 12 million restricted activity days,
- 1.5 million school absence days, (2.48 days per child with asthma), and
- 51 school age children each year will die of asthma.

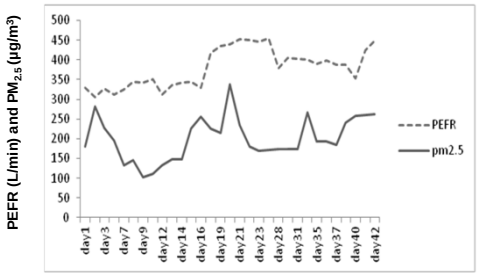
Results in Kathmandu

- The study in Kathmandu contrasted an urban roadside school with a semi-urban school in a residential area.
- The 24 hour mean concentration of $PM_{2.5}$ was 203 µg/m³ in the urban school and 137 µg/m³ in the semi-urban school.
- These concentrations exceeded the Nepal daily $PM_{2.5}$ standard of 40 µg/m³.

Results in Kathmandu

- The PEFR level of the students at the urban school varies with the changing levels of $PM_{2.5}$ concentration which ranged between 100 µg/m^3 and nearly 340 µg/m^3.
- The PEFR levels of younger (10-12 years) children seem to be correlated with the changes in $PM_{2.5}$ concentrations in the initial days and later days of the assessment.
- The PEFR levels of female children also seem to be associated with the variation in daily $PM_{2.5}$ concentrations on a few days.

The relationship between peak expiratory flow rate (PEFR) (L/min) of 10 to 12 year old children and $PM_{2.5}$ (µg/m^3) concentration at the urban roadside school in Kathmandu (NHRC and ICIMOD 2013)

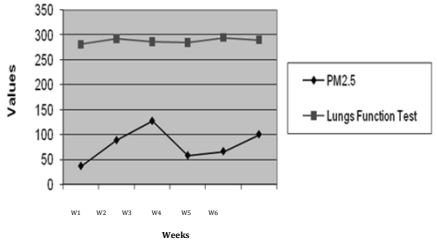


Days from the commencement of monitoring

Results in Islamabad

- The mean concentration of $PM_{2.5}$ in Islamabad was 81 µg/m^3 with a range of 25-142 µg/m^3
- Measurements frequently exceeded the 24 hour air quality standard in Pakistan of 40 µg/m^3.
- The peak expiratory flow rate (PEFR) ranged from 120 L/min to 420 L/min, with a mean of 287 L/min.

Results in Islamabad



Weekly average PM2.5 and PEFR in Islamabad. The vertical axis refers to both PEFR in L/minute and $PM_{2.5}$ in µg/m^3

Social and Economic Impacts

These and other studies suggest that $PM_{2.5}$ concentrations in ambient air have a significant adverse economic impact on the families of affected children.

It has been estimated that the reduction of PM_{10} concentration by 20% - 80% in Dhaka could allow for:

- avoidance of 1,200 to 3,500 deaths,
- 80 to 235 million cases of sickness, and
- a saving of US$ 169 to 492 million equivalent to 0.34 – 1.0 % of Gross National Income (World Bank, 2006).

Further steps

- A regional study should be considered to quantify the health, social and economic costs of ambient health damaging $PM_{2.5}$ particles in Malé Declaration countries, reporting to the Governments.
- The aim is to enable more thorough national assessments of impacts, policy options, costs and health benefits of key options to reduce the burden of disease caused by air pollution.
- This could be conducted by a team nominated by governments of Malé Declaration countries using national data and working to a common methodology.

Conclusion

If emissions of $PM_{2.5}$ in Dhaka, Islamabad, Kathmandu and similar cities could be reduced the harmful impacts on the respiratory health of children could be substantially decreased with social and economic benefits

Thank you