Particulate Air Pollution and Health Effects in a Megacity of Asia (Karachi)

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ABSTRACT

Karachi, Pakistan is one of the largest and most polluted metropolitan cities in south Asia. Air quality was assessed using 24-hour fine particulate matter ($PM_{2.5}$) samples collected from two sites, Korangi and Tibet Center. Daily emergency room (ER) visits and hospital admissions for cardiovascular diseases were obtained at three major tertiary hospitals. Particulate levels were extraordinarily high. Mean $PM_{2.5}$ levels in Karachi exceeded the WHO's 24 h air quality guidelines by a factor of greater than 5-fold. Results show that the extremely elevated concentrations of $PM_{2.5}$ are associated with significantly elevated rates of hospital admissions and ER visits for cardiovascular diseases.

Keywords: Air pollution; particulates; Karachi; cardiovascular diseases

INTRODUCTION

Air Pollution impacts on mortality and health are a significant public health issue worldwide. Population-based studies have documented health risks resulting from short-term exposure to air pollutants. According to a recent World Health Organization (WHO) report, air pollution has become the world's single biggest environmental health risk, linked to around 7 million – nearly one in eight deaths in 2012. Around 80% of the 3.7 million deaths from outdoor air pollution came as a result of stroke and heart disease, 11% from lung diseases, and 6% from cancers. Southeast Asia is now the most polluted region in the world, with 2.6 million deaths related to outdoor air pollution. These new estimates are based not on a significant increase in pollution, but on improved knowledge of the links between air pollutants and cardiopulmonary diseases, cancers, diabetes, neurological disorders (Alzheimer, dementia), mental health, low birth weight, and tuberculosis.

Most studies investigating the health effects of air pollution have been conducted in developed countries where concentrations of air pollution, climatic conditions, and many other factors are significantly different from those in most developing countries. The burden of deaths and healthy life-years lost due to outdoor air pollution worldwide is not equally distributed: ~ 65% of the deaths and lost life-years occur in developing countries of Asia. This disparity demonstrates an urgent need for conducting and evaluating environmental studies on the health effects of air pollution in major cities of Asia.

The concurrent increase in the population, urbanization, industrialization, energy use, and the number of automobiles on the roads every year is giving rise to a threateningly high rate of increase in air pollutants in the urban areas of Pakistan (population = 220 million). Karachi, a megacity in Pakistan, has a population of more than 20 million and is one of the most heavily polluted mega cities in the world with serious human health risks. The city has a huge industrial base and is congested with a large number of motor vehicles (> 2.21 million). Not a single study of the health effects of air pollution has been performed in this developing megacity.

OBJECTIVES

We have investigated the short-term effects of $PM_{2.5}$ and its components in ambient air on hospital admissions and ER visits among residents living in one of the largest cities of Southeast Asia, Karachi, Pakistan.

METHODOLOGY

Air pollution monitoring for 24 h $PM_{2.5}$ was conducted at two fixed stations located at Korangi (industrial/residential) and Tibet Center (commercial/residential). Daily records of hospitalizations and ER visits for cardiovascular diseases (CVD) at three major hospitals serving the city were collected. Single- and multi-pollutant lagged generalized linear time-series models were utilized to analyze daily counts of hospital, meteorological, and pollutant data.

CONCLUSIONS/RESULT

- This study is one of the first to investigate the relationship between particulate air pollution and cardiovascular diseases in a megacity in a developing country where particulate levels are extraordinarily high.
- $PM_{2.5}$ levels averaging about 5 – 7-fold higher than the WHO guideline (25 µg/m^3) on a "good" day, and with frequent peaks at levels as high as 279 µg/m^3.
- Higher levels of $PM_{2.5}$ are associated with a striking elevation in rates of ER visits and hospital admissions for cardiovascular diseases (ischemic heart disease, hypertension, myocardial infarction).
- Statistically strongest relationships were observed for all patients (RR = 1.499, 95% CI = 1.240 – 1.812 for Korangi; RR = 1.778, 95% CI = 1.349 – 2.345 for Tibet Center) and hospital admissions (RR = 1.613, 95% CI = 1.274 – 2.043 for Korangi; RR = 2.036, 95% CI = 1.424 – 2.911 for Tibet Center) for $PM_{2.5}$ concentrations (151 – 200 µg/m^3).
- Results of this study have substantiated the need for policy interventions and more stringent controls on atmospheric emissions in order to protect human health and the environment. Also, this investigation has provided a data set that may be used for subsequent human health risk assessments for Karachi, Pakistan.

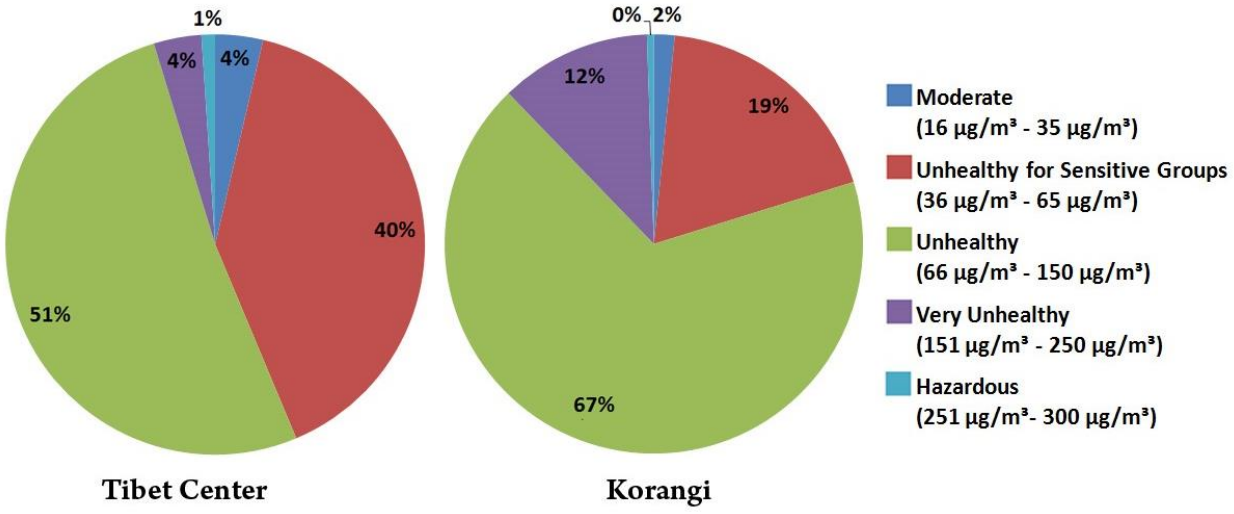

Fig 1. Air Quality Index (AQI) at Korangi and Tibet center in Karachi, Pakistan during the study period.

Table 1. Relative risk estimates (95% CI) of cardiovascular hospital admissions and ER visits associated with 50 µg/m3 increase in PM2.5 (µg/m3), during the study period.

	Relative Risk			
	Korangi		Tibet Center	
$PM_{2.5}$ (µg/m^3) [a]	ER Visits	Hospital Admissions	ER Visits	Hospital Admissions
51 < $PM_{2.5}$ < 100	1.155 (0.935, 1.427)	1.243** (1.028, 1.503)	0.980 (0.838, 1.147)	1.057 (0.927, 1.205)
101 < $PM_{2.5}$ < 150	1.186 (0.951, 1.479)	1.321*** (1.086, 1.607)	1.168 (0.927, 1.472)	1.025 (0.832, 1.263)
151 < $PM_{2.5}$ < 200	1.339** (1.037, 1.730)	1.613**** (1.274, 2.043)	1.342* (0.940, 1.914)	2.036**** (1.424, 2.911)
201 < $PM_{2.5}$ < 300 [b]	1.421 (1.013, 1.993)	1.559** (1.087, 2.237)	1.190 (0.882, 1.606)	1.284* (0.951, 1.733)

[a] $PM_{2.5}$ concentrations of less than 50 µg/m^3 were used a reference.
[b] Two categories were combined.
* p < 0.1; ** p < 0.05; *** p < 0.01; **** p < 0.001

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