Public Health Impact of Particulate Matter Pollution in Nepal: A Review

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Abstract

Worldwide air pollution continues to pose a significant threat to human health. Air pollution is a major environmental risk to health. According to Yale Environmental Performance Index (EPI) 2016, Nepal ranked on 149 among 180 countries in terms of air quality. Nepal’s capital city Kathmandu, which also chokes beneath a blanket of pollution, has neither data nor any proper information available regarding air quality. Different natural and anthropogenic reasons are responsible for the emission of complex mixtures of air pollutants, many of which are harmful to health. Particulate matter also consists of a complex mixture of solid and liquid particles of organic and inorganic substances suspended in the air. Particulate matter affects more people than any other pollutant. There is a close, quantitative relationship between exposure to high concentrations of small particulates (PM10 and PM2.5) and increased mortality or morbidity, both daily and over time. The effects of particulate matter on health occurs at levels of exposure currently being experienced by many people both in urban and rural areas and in developing and developing countries. Fine particles are more dangerous than coarse particles, as PM2.5 can penetrate into the alveolar regions of the lungs these particles may cause serious damage to developing lungs of children. Ambient particulate matter is responsible for harmful effects on health, even in the absence of other air pollutants. Long-term exposure to current ambient particulate matter concentrations may affect the lungs of both children and adults and may reduce life expectancy by a few months, mainly in subjects with pre-existing heart and lung diseases. Acute exposure studies that evaluated short-term (usually daily) variations in health end points such as hospitalizations, and lung function associated with short-term variations in levels of pollution. Long-term exposure studies that evaluated short-term (usually daily) variations in health end points such as hospitalizations, and lung function associated with short-term variations in levels of pollution. Long-term (months, years) exposure can cause some chronic health issues like includes, increased mortality rates, reduced survival times, chronic cardiopulmonary disease and reduced lung function. The issues of particulate matter pollution should be addressed by the national level policy that can be applied at different public and private sectors. The government of Nepal has introduced several policies, legislation and standards related to air pollution. Those policies and legislation need to be implemented to fight against the pollution.

Keywords: Particulate Matter Pollution, Impact on Human Health

I. INTRODUCTION

Clean air is considered to be a basic requisite of human health and wellbeing. But, worldwide air pollution continues to pose a significant threat to human health. WHO has defined air pollution as contamination of the indoor or outdoor environment by any physical, biological or chemical agent that modifies the natural properties of the atmosphere.

Air pollution is a major environmental risk to health. If we can reduce air pollution levels, countries can reduce the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma. Ambient (outdoor air pollution) is a major environmental health problem affecting everyone in developed and developing countries alike. Outdoor air pollution in both cities and rural areas was estimated to cause 3.7 million premature deaths worldwide in 2012. Data shows that some 88% of those premature deaths occurred in low- and middle-income countries, and the greatest number in the WHO Western Pacific and South-East Asia regions with annual mean levels often exceeding 5-10 times WHO limits, followed by low-income cities in the Western Pacific Region.

According to Yale Environmental Performance Index (EPI) 2016, Nepal ranked on 149 among 180 countries in terms of air quality. Nepal’s capital city Kathmandu, which also chokes beneath a blanket of pollution, has neither data nor any proper information available regarding air quality. According to Studies conducted by ICIMOD in Kathmandu have found that more than 50% of the 196 tonnes of emissions that we produce each year consists of small particles called PM2.5 and PM10.

Different natural and anthropogenic reasons are responsible for the emission of complex mixtures of air pollutants, many of which are harmful to health. Those air pollutants of major public health concern include particulate matter, ozone, carbon monoxide, sulphur dioxide and nitrogen dioxide. Of all of these pollutants, particulate matter has the greatest effect on human health. (World Health Organization. Health aspects of air pollution with particulate matter, ozone and nitrogen dioxide: report on
a WHO working group, Bonn, Germany 13-15 January 2003). Major source of such particles in Nepal is the exhaust from various vehicles and the dust these vehicles kick up on unpaved and mismanaged roads as well as construction works. Even though almost a third of the vehicles that run on the street today do not comply with the emission standards and the majority of road networks are grossly mismanaged, no solutions have been worked out to address such issues. Other sources are fuel combustion from stationary sources such as power plants, industry, households or biomass burning. Migration and urbanization are the part of the fast-paced growth of industrialized cities in South Asia. If not managed properly, urbanization and the accompanying increase in population, number of vehicles, and industry, can all play a part in degrading the environment.

Particulate matter also consists of a complex mixture of solid and liquid particles of organic and inorganic substances suspended in the air. The common chemical constituents of particulate matter include sulphates, nitrates, ammonium, other inorganic ions such as ions of sodium, potassium, calcium, magnesium and chloride, organic and elemental carbon, crustal material, particle-bound water, metals (including cadmium, copper, nickel, vanadium and zinc) and polycyclic aromatic hydrocarbons (PAH). In addition, biological components such as allergens and microbial compounds are found in PM.

Suspected mixture of solid and liquid particles that vary in size, composition, and origin. The size distribution of total suspended particles (TSPs) in the atmosphere is tri-modal and includes coarse particles, fine particles, and ultrafine particles. Coarse particles (often defined as those with an aerodynamic diameter > 2.5 μm) are often naturally occurring and derived primarily from soil and other crustal materials. Fine particles (PM2.5) are derived chiefly from combustion processes in transportation, manufacturing, power generation, etc. Relative to coarse particles, they more readily penetrate indoors, are transported over longer distances, and are somewhat uniform within communities, resulting in highly ubiquitous exposure.

According to the latest urban air quality database, 98% of cities in low- and middle income countries with more than 100 000 inhabitants do not meet WHO air quality guidelines. There is no much data available about particulate matter concentration in Nepal. Only available data of Kathmandu valley, one of the most densely polluted city of the country has annual mean of particulate matter PM 10, 88 μg/m3 in 2013. Which is high as compare to WHO guideline (20 μg/m3). Similarly, in 2015, study conducted by NHRC shows that annual mean of particulate matter PM 2.5 is 49 μg/m3, which is almost 5 times higher than WHO guideline (10 μg/m3). These data explain the vulnerability of cities like Kathmandu in Nepal.

Particulate matter affects more people than any other pollutant. There is a close, quantitative relationship between exposure to high concentrations of small particulates (PM10 and PM2.5) and increased mortality or morbidity, both daily and over time. Small particulate pollution has health impacts even at very low concentrations – indeed no threshold has been identified below which no damage to health is observed.

II. HEALTH IMPACT OF PARTICULATE MATTER

The effects of particulate matter on health occur at levels of exposure currently being experienced by many people both in urban and rural areas and in developed and developing countries. Outdoor air pollution, mostly associated with particulates ranked sixth in importance among all health risks in South Asia where it contributed to 712,000 deaths in 2010. The size of particles is important as it determines the extent of penetration of particles into the respiratory system. Recent studies have identified fine particles called PM2.5 (particles with a mean aerodynamic diameter of 2.5 micrometres or smaller) as being especially harmful because they may reach and persist in the alveolar region of the lungs.

Fine particles are more dangerous than coarse particles. Apart from the size of the particles, other specific physical, chemical, and biological characteristics that can influence harmful health effects include the presence of metals, PAHs, other organic components, or certain toxins. When particulate matter is combined with other air pollutants, the individual effects of each pollutant is accumulated. In certain cases, especially for combinations of particulate matter with ozone or allergens, effects were shown to be even greater than the sum of the individual effects. When particulate matter interacts with gases, this interaction changes its composition and, therefore, its effects.

As PM2.5 can penetrate into the alveolar regions of the lungs these particles may cause serious damage to developing lungs of children. As most lung alveoli are formed postnatally, changes in the lung continue through adolescence and the developing lungs of children are more vulnerable to the adverse effects of air pollution than adult lungs.

Particulate matter is associated with a broad spectrum of acute and chronic illness, such as lung cancer, chronic obstructive pulmonary disease (COPD) and cardiovascular diseases. Worldwide, it is estimated to cause about 16% of lung cancer deaths, 11% of COPD deaths, and more than 20% of ischaemic heart disease and stroke. WHO country profile Nepal shows that in 2012, chronic obstructive pulmonary disease (COPD) as the number one cause of death whereas lower respiratory infection was the fourth major cause of death in Nepal, for this many factors are responsible. Among them air pollution is one of them.

Ambient particulate matter is responsible for harmful effects on health, even in the absence of other air pollutants. Long-term exposure to current ambient particulate matter concentrations may affect the lungs of both children and adults and may reduce life expectancy by a few months, mainly in subjects with pre-existing heart and lung diseases.

The health effects of inhalable PM are well documented. There is good evidence of the effects of short-term exposure to PM10 on respiratory health, but for mortality, and especially as a consequence of long-term exposure, PM2.5 is a stronger risk factor than the coarse part of PM10 (particles in the 2.5–10 μm range). All-cause daily mortality is estimated to increase by 0.2–0.6% per 10 μg/m3 of PM10. Long-term exposure to PM2.5 is associated with an increase in the long-term risk of cardiopulmonary mortality by 6–13% per 10 μg/m3 of PM2.5.
Similarly, acute exposure studies that evaluated short-term (usually daily) variations in health end points such as hospitalizations, and lung function associated with short-term variations in levels of pollution. Long term (months, years) exposure can cause some chronic health issues like includes, increased mortality rates, reduced survival times, chronic cardiopulmonary disease and reduced lung function. Although the effects of continued short-term exposure may contribute to the initiation or exacerbation of chronic disease, those affected by the acute exposures may reflect a distinct, susceptible subgroup with underlying or existing disease or unrecognized vulnerability. 

Susceptible groups with pre-existing lung or heart disease, as well as elderly people and children, are particularly vulnerable. For example, exposure to PM affects lung development in children, including reversible deficits in lung function as well as chronically reduced lung growth rate and a deficit in long-term lung function. There is no evidence of a safe level of exposure or a threshold below which no adverse health effects occur. The exposure is ubiquitous and involuntary, increasing the significance of this determinant of health.

It is estimated that approximately 3% of cardiopulmonary and 5% of lung cancer deaths are attributable to PM globally. In the European Region, this proportion is 1–3% and 2–5%, respectively, in various sub-regions. Results emerging from a recent study indicate that the burden of disease related to ambient air pollution may be even higher. This study estimates that in 2010, ambient air pollution, as annual PM2.5, accounted for 3.1 million deaths and around 3.1% of global disability-adjusted life years. Results from the scientific project Improving Knowledge and Communication for Decision-making on Air Pollution and Health in Europe, which uses traditional health impact assessment methods, indicate that average life expectancy in the most polluted cities could be increased by approximately 20 months if the long-term PM2.5 concentrations was reduced to the WHO (AQG) annual level.

A number of studies have indicated that PM10 exposure during pregnancy, in addition to NO2 exposure, is able to impact pregnant women and neonates. Heterogeneous results were observed when comparing 14 studies that assessed exposure to pollution during pregnancy and birth weight.

Morbidity outcome of particulate matter pollution according ages
1) Bronchitis symptoms in children under the age of 18 years;
2) Chronic bronchitis in adults older than 30 years;
3) Asthma attacks, all ages;
4) Cardiovascular, cerebrovascular (possibly) and respiratory hospital admissions, all ages;
5) Urgent care visits due to asthma (and possible other respiratory outcomes) and cardiovascular disease, all ages; and
6) Restricted activity days, adults.

III. WAY FOREWORD

The issues of particulate matter pollution should be addressed by the national level policy that can be applied at different public and private sectors. The government has introduced several policies, legislation and standards related to air pollution. However, these have not been followed up with comprehensive plans and programmes. Constitution of Nepal 2072 has guaranteed every person the right to live in a clean environment as a fundamental right and mandate state to make necessary arrangements to maintain clean environment. Similarly, Environmental Protection Act introduced in 1997 make legal provision to maintain clean and healthy environment by minimizing adverse impacts as far as possible. National Ambient Air Quality Standard (NAAQS) was introduced in 2003 and updated in 2012.

There are many government and private as well as international initiatives to minimize air pollution. Some of the government initiatives to tackle with air pollution includes, establishments of ambient air quality monitoring system in some parts of Kathmandu valley, vehicle inspection and emission testing is being carried out all over the nation, ban on polluting vehicles by replacing with safa tempo, road improvement, footpaths and cycle lanes etc. But most of the initiatives are concentrated on Kathmandu valley and other cities of Nepal are being neglected.

Some of the initiatives can be development and implementation of a Clean Air Action Plan with both immediate and long-term strategies and targets to reduce the air pollution. Improvement of public transportation system and introduce bus rapid transit system. Promotion of clean transportation such as walking, cycling and electric vehicles as well as introduction of more stringent emission standards and fuel quality standard also can help to reduce these pollutions. Effective implementation of green sticker system and remove gross polluters, regular monitoring air quality, promoting energy efficiency and cleaner technologies in industries, such as Vertical Shaft Brick Kiln and zigzag kiln technology for brick productions, promotion of alternative energy such as solar for electricity generation also can be effective strategies to tackle with this ambient air pollution. Other strategies might be effective waste management system to stop disposal of waste in public places and control open burning of waste and establish a dedicated and sustainable funding mechanism by effectively using the environmental tax for improving air quality. Public awareness campaigns are required to inform the people about the hazards of particulate matter pollution and what they can do to avoid or minimize such pollution.

REFERENCES


