Perspective

The Impact of Haze Weather on Health: A view to Future

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In January 2013, China suffered large-scale haze weather four times, affecting 30 cities in all. The average number of haze weather days in many regions was higher than the same period in every year since 1961. $PM_{2.5}$, which is defined as fine particulate matter with an aerodynamic diameter of 2.5 micrometers or less, is the main health hazard in the context of haze weather. It can carry large amounts of poisonous and harmful substances, and penetrate deep into the lungs and blood circulation through the respiratory tract, thereby affecting human health.

The Global Burden of Disease Study 2010 ranked particulate matter as the 8th highest cause of death worldwide, when considering estimated deaths attributable to the independent effects of 67 risk factors. In China，this ranking could be as high as 4th, accounting for approximately 1.2 million premature deaths in 2010. In 2007, the World Bank estimated that economic losses relating to the health hazards of ambient air pollution could be above 520 billion Yuan (about US$87 billion) per year in China.

The health effects of haze weather studies mainly focus on $PM_{2.5}$. Environmental epidemiology research in recent decades has proved that short or long-term exposure to ambient $PM_{2.5}$ was associated with increased mortality and morbidity, reduction in life expectancy and additional respiratory and cardiovascular diseases. $PM_{2.5}$ could penetrate deeply into the lungs through the respiratory tract due to its small size, and irritate and corrode the alveolar wall. The resulting impaired lung function would show as coughs, wheezes, respiratory disorders and other symptoms, and increase the risks of bronchial asthma, chronic obstructive pulmonary disease (COPD), emphysema and other respiratory diseases. The main causes of cardiovascular morbidity and mortality are ascribed to the changes in blood pressure, secretion of C-reactive protein (CRP), fibrinogen or other cytokines, disruption of autonomic nervous system activity by decreased heart rate variability, and dysfunction in coagulation or vascular endothelium, causing myocardial ischemia, myocardial infarction, arrhythmia, atherosclerosis, and so on. $PM_{2.5}$, once deposited deeply within the lungs, appeared to access the circulatory system by different transfer mechanisms, resulting in distribution throughout the body, including the brain. Ultrafine particles of even smaller size may even pass through the blood-brain barrier or olfactory nerve, causing ischemic cerebrovascular disease, cognitive impairment, neurological inflammation and neuronal damage. Moreover, large amounts of toxic compounds, for example, heavy metals, monoaromatic hydrocarbons [benzene, toluene, ethylbenzene, and xylenes (BTEX)] and other organic chemicals, adhered to the surface of $PM_{2.5}$ and increased their toxicity, interfering with chromosomes, DNA and other genetic material, even causing cancers.

Further studies have been conducted to identify the impact of $PM_{2.5}$ on health, and the scope of these studies has been gradually expanded. However, research still has not found a way to meet people's health needs. To provide more evidence-based prevention and control strategies, research about the health impacts of haze weather should focus on the questions below.

First, researchers need to pay attention to the synergy effects of $PM_{2.5}$ and other air pollutants. Haze is mixed up with dust, smoke and other air pollutants and it interacts with the natural environment. Although the present statement focuses on $PM_{2.5}$, it is believed that other air pollutants (ozone, nitrogen dioxide, carbon monoxide, and sulfur dioxide) and meteorological elements (weather, temperature and seasons) may also affect health independently or in conjunction with $PM_{2.5}$ exposure.

Second, particulates are a mixture of tiny solid and liquid particles in the air, which vary in origin, size and composition. Health hazards of air pollution present strong regional characteristics, so that differences between distinct geographical regions

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and functional areas, such as urban and rural populations, should be studied. Moreover, researchers should consider the relationship between particle size, surface chemicals, and toxicity. Chemical tracers and source apportionment techniques will be helpful in addressing this issue.

Third, to establish a standardized research base (a prospective cohort) as a platform for environmental and health research is critical and urgent. Once established, multi-platform technologies, such as various ‘Omics’ detection technologies and health impact assessments on a variety of environmental pollutants can be developed.

Last but not least, many studies showed that there are various biological responses to different pollutants. However, oxidative stress seemed to be the key link, around which more animal exposure and toxicological studies on the mechanisms of haze-induced toxicity should be conducted. In addition, more specific biomarkers need to be identified.