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WATER POLLUTION AND ITS EFFECT ON ENVIRONMENT

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Abstract : Hazardous chemicals escape to the environment by a number of natural and/or anthropogenic activities and may cause adverse effects on human health and the environment. Increased combustion of fossil fuels in the last century is responsible for the progressive change in the atmospheric composition. Air pollutants, such as carbon monoxide (CO), sulfur dioxide (SO2), nitrogen oxides (NOx), volatile organic compounds (VOCs), ozone (O3), heavy metals, and respirable particulate matter (PM2.5 and PM10), differ in their chemical composition, reaction properties, emission, time of disintegration and ability to diffuse in long or short distances. Air pollution has both acute and chronic effects on human health, affecting a number of different systems and organs. It ranges from minor upper respiratory irritation to chronic respiratory and heart disease, lung cancer, acute respiratory infections in children and chronic bronchitis in adults, aggravating pre-existing heart and lung disease, or asthmatic attacks. In addition, short- and long-term exposures have also been linked with premature mortality and reduced life expectancy. These effects of air pollutants on human health and their mechanism of action are briefly discussed.

Keywords:

INTRODUCTION

December, 2002, marks the 50th anniversary of the great smog event in London, UK. Stagnant weather conditions caused a sharp increase in the concentration of air pollutants, and over several days, more than three times as many people died than expected, leading to an estimated

excess death toll of over 4000. Concentrations of sulphur dioxide and smoke reached several thousands of μg per m3. The London 1952 smog was not without precedent-similar events occurred in the Meuse valley, Belgium, in 1930, and elsewhere.

Conditions have changed; effective legislation has eliminated most of the air pollution of 50 years ago. Yet the 1952 London smog event keeps attracting the attention of contemporary air pollution scientists. One question that remains important is the extent to which air pollution affects life expectancy. The 1954 report1 suggests that death occurred mostly in individuals who were on the brink of death already, but if this were the case, the death rate should have dropped sharply after the episode. On the contrary, the death rate remained high for several months, and a recent re-analysis of the data indicates that the number of additional deaths due to the episode was about 12000. Another question is that of causality; although concentrations of sulphur dioxide and black smoke were greatly increased during the episode, sulphuric acid was thought to be the critical component. On this basis, bottles of ammonia were distributed among bronchitis patients so that they could neutralise acids during episodes of air pollution. These give access to comprehensive reviews produced by organisations such as the World Health Organisation, the European Union, the US Environmental Protection Agency, and the Department for Environment, Food and Rural Affairs (panel).

AIR QUALITY GUIDELINES AND STANDARDS

Several guidelines and standards exist for ozone, nitrogen dioxide, and particulate matter in ambient air. The table lists the most recent air quality guidelines and standards recommended by WHO, the US Environmental Protection Agency, and the European Union (EU). The EU standards are targets to be reached in 2005 or 2010.

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The most remarkable difference lies in the annual value for nitrogen dioxide. The WHO and EU value is only 40% of the US value.

WHO has not proposed guidelines for particulate matter, arguing that it was unable to define a threshold below which no adverse effects are expected. Instead, dose response information was provided to help policy makers decide when setting a standard. The effect estimates given in the table were based on information as it was available until 1996. As described earlier, the newest large-scale studies tend to show somewhat smaller effects per unit particulate matter. For particulate matter, the proposed US standards for PM2·5 are not very different from the EU 2010 annual average and the 2005 24-h average for PM10, considering that PM2·5 usually comprises about 60-70% of the PM10 concentration, and considering the number of exceedances allowed in the 24-h EU standard.

All guidelines and standards mentioned in the table are subject to periodic revision when new scientific information becomes available. WHO has just recently started a process to re-evaluate the guidelines for these three pollutants.

Maximum concentration allowed when averaged over time

	1 h	8 h	24 h	1 year
Ozone (µg/m3)				
WHO	……	120	….	….
EPA	235	157	….	….
EU	…..	120 (2010)	….	….
Nitrogen dioxide (µg/m3)				
WHO	200	….	….	40
EPA	….	….	….	100
EU	200 (2010)	….	….	40(2010)
PM10 (µg/m3)				
WHO (mortality relative risk per 10 µg/m3)†	….	….	1·007	1.10
EPA	….	….	150	50
EU	….	….	50‡2005),	40 (2005),
			50§(2010)	20(2010)
PM2·5 (µg/m3)				
WHO (mortality relative risk per 10 _g/m3)†	….	….	1.015	1.14
EPA	…..	….	65	15

Table show short averaging times are used when the guideline was developed to prevent acute effects, long averaging times to prevent long-term effects. †No guideline value for particulate matter was given because no threshold concentration was identified below which no effects on health were pecked. Relative risk estimates were provided to help policy makers set standards based on quantitative dose-response information. ‡To be exceeded on no more than 35 days per year. §To be exceeded on no more than 7 days per year.

WHO, US Environmental Protection Agency (EPA), and European Union (EU) air quality guidelines and standards for ozone, nitrogen dioxide, and particulate matter

public-health benefits would be expected from bringing air pollution concentrations far below this level. Theoretical and empirical work has been done to shed light on this issue. In an analysis of NMMAPS data, no evidence was found for a threshold for PM10 and daily all-cause and cardio respiratory mortality. By contrast, a threshold of about 50 µg/m3 was estimated for non-cardio respiratory causes of death, illustrating the specificity of the approach. Earlier analyses restricted the analysis to concentrations below a certain value.37,110 These analyses suggest that a threshold for acute effects of ozone on lung function changes must lie well below 100 µg/m3 as an hourly maximum.

CLASSIFICATION OF AIR POLLUTANTS

A. Primary-secondary pollutants **(i) Primary:** pollutants emitted directly into the atmosphere (eg,SO2, some NOx species, CO, pM) **(ii) Secondary:** pollutants that form in the air as a result of chemical reactions with other pollutants and gases (eg, ozone, NOx, and some particulates)
B. Indoor-outdoor pollutants **(i) Indoor pollutants** (a) Sources: cooking and combustion, particle resuspension, building materials, air conditioning, consumer products, smoking, heating, biologic agents (b) Products: Combustion products (eg, tobacco and wood smoke), CO, CO2, SVOC (eg, aldehydes, alcohols, alkanes, and ketones), microbial agents and organic dusts, radon, manmade vitreous fibers **(ii) Outdoor pollutants** (a) Sources: industrial, commercial, mobile, urban, regional, agricultural, natural (b) Products: SO2, ozone, NOx, CO, PM, SVOC
C. Gaseous-particulate pollutants **(i) Gaseous:** SO2, NOx, ozone, CO, SVOC (eg, PAH, dioxins, benzene, aldehydes, 1,3-butadiene) **(ii) Particulate:** coarse PM(2.5-10mm; regulatory standard = PM10), fine PM(0.1-2.5mm; regulatory standard = PM2.5); ultrafine PM (<0.1 mm; not regulated)

NOx, Nitrogen oxides; SVOC, specific volatile organic compounds.

HEALTH EFFECTS

Sporadic air pollution events, like the historic London fog in 1952 and a number of short and long term epidemiological studies investigated the effects of air quality changes on human health. A constant finding is that air pollutants contribute to increased mortality and hospital admissions (Brunekreef and Holgate, 2002). The different composition of air pollutants, the dose and time of exposure and the fact that humans are usually exposed to pollutant mixtures than to single substances, can lead to diverse impacts on human health. Human health effects can range from nausea and difficulty in breathing or skin irritation, to cancer. They also include birth defects, serious developmental delays in children, and reduced activity of the immune system, leading to a number of diseases. Moreover, there exist several susceptibility factors such as age, nutritional status and predisposing conditions. Health effects can be distinguished to acute, chronic not including cancer and cancerous. Epidemiological and animal model data indicate that primarily affected systems are the cardiovascular and the respiratory system. However, the function of several other organs can be also influenced (Cohen et al., 2005; Huang and Ghio, 2006; Kunzli and Tager, 2005; Sharma and Agrawal, 2005).

EFFECTS OF AIR POLLUTANTS ON DIFFERENT ORGANS AND SYSTEMS

1. Respiratory system

Numerous studies describe that all types of air pollution, at high concentration, can affect the airways. Nevertheless, similar effects are also observed with long-term exposure to lower pollutant concentrations. Symptoms such as nose and throat irritation, followed by bronchoconstriction and dyspnoea, especially in asthmatic individuals, are usually experienced after exposure to increased levels of sulphur dioxide (Balmes et al., 1987), nitrogen oxides (Kagawa, 1985), and certain heavy metals such as arsenic, nickel or vanadium. In addition particulate matter that penetrates the alveolar epithelium (Ghio and Huang, 2004) and ozone initiate lung inflammation (Uysal and Schapira, 2003).

2. Cardiovascular system

Carbon monoxide binds to hemoglobin modifying its conformation and reduces its capacity to transfer oxygen (Badman and Jaffe, 1996). This reduced oxygen availability can affect the function of different organs (and especially high oxygen consuming organs such as the brain and the heart), resulting in impaired concentration, slow reflexes, and confusion. Apart from lung inflammation, systemic inflammatory changes are induced by particulate matter, affecting equally blood coagulation (Riediker et al., 2004). Air pollution that induces lung irritation and changes in blood clotting can obstruct (cardiac) blood vessels, leading to angina or even to myocardial infraction (Vermylen et al., 2005).

3. Nervous system

The nervous system is mainly affected by heavy metals (lead, mercury and arsenic) and dioxins. Neurotoxicity leading to neuropathies, with symptoms such as memory disturbances, sleep disorders, anger, fatigue, hand tremors, blurred vision, and slurred speech, have been observed after arsenic, lead and mercury exposure (Ewan and Pamphlett, 1996; Ratnaike, 2003). Especially, lead exposure causes injury to the dopamine system, glutamate system, and N-methyl-D-Aspartate (NMDA) receptor complex, which play an important role in memory functions (Lasley and Gilbert, 2000; Lasley et al., 2001). Mercury is also responsible for certain cases of neurological cancer

4. Urinary system

Heavy metals can induce kidney damage such as an initial tubular dysfunction evidenced by an increased excretion of low molecular weight proteins, which progresses to decreased glomerular filtration rate (GFR). In addition they increase the risk of stone formation or nephrocalcinosis (Damek-Poprawa and Sawicka-Kapusta, 2003; Jarup, 2003; Loghman-Adham, 1997) and renal cancer (Boffetta et al., 1993; Vamvakas et al., 1993).

5. Digestive system

Dioxins induce liver cell damage (Kimbrough et al., 1977), as indicated by an increase in levels of certain enzymes in the blood (see following discussion on the underlying cellular mechanisms of action), as well as gastrointestinal and liver cancer (Mandal, 2005).

6. Exposure during pregnancy

It is rather important to mention that air pollutants can also affect the developing foetus (Schell et al., 2006). Maternal exposure to heavy metals and especially to lead, increases the risks of spontaneous abortion and reduced fetal growth (preterm delivery, low birth weight). There are also evidences suggesting that parental lead exposure is also responsible for congenital malformations (Bellinger, 2005), and lesions of the developing nervous system, causing important impairment in newborn's motor and cognitive abilities (Garza et al., 2006).

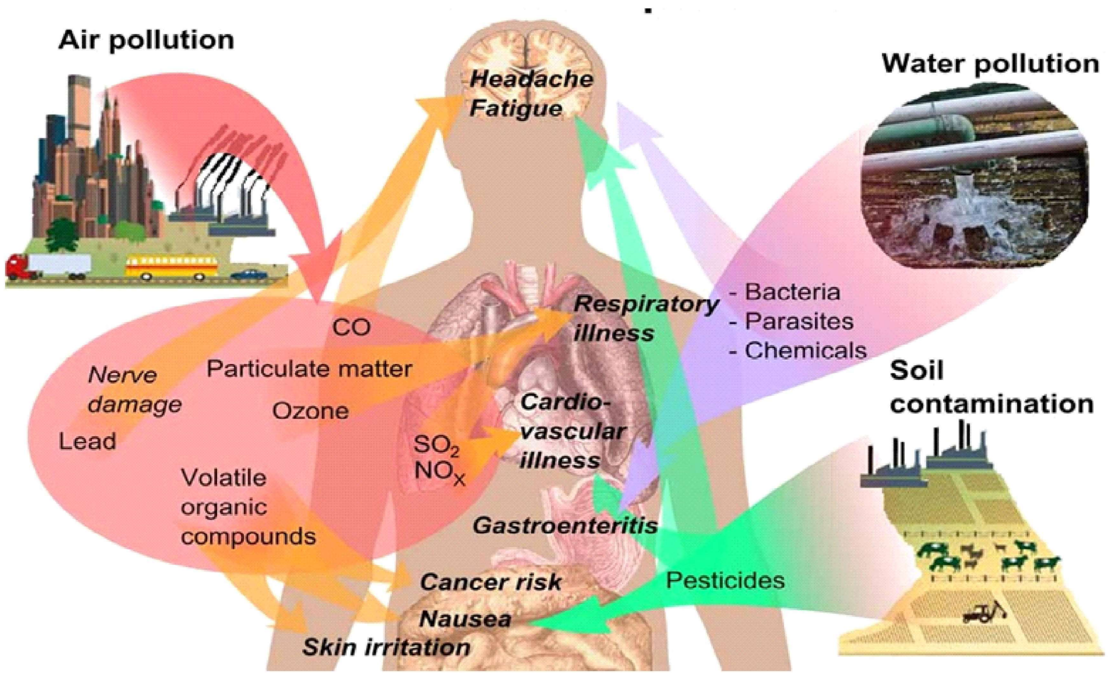

Fig: Health effect of pollutions

CONCLUSION

This brief review presents the adverse effects of a number of (air) pollutants in human health. As shown, major impairments of different organs can be observed. The main conclusion drawn is that, in view of increased exposure of humans in a diversity of pollutants, dietary interventions, rich in plant-derived foods, may protect or decrease their effects on different organs. This conclusion is supported by a number of epidemiological studies on the beneficial effect of a Mediterranean- type diet on human health.

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