WORLD HEALTH ORGANIZATION
EUROPE

Fact sheet EURO/04/05
Berlin, Copenhagen, Rome, 14 April 2005

Particulate matter air pollution: how it harms health

Definition

Particulate matter (PM) is an air pollutant consisting of a mixture of particles that can be solid, liquid or both, are suspended in the air and represent a complex mixture of organic and inorganic substances. These particles vary in size, composition and origin. Their properties are summarized according to their aerodynamic diameter, called particle size.

- The coarse fraction is called PM_{10} (particles with an aerodynamic diameter smaller than 10 μm), which may reach the upper part of the airways and lung.
- Smaller or fine particles are called $PM_{2.5}$ (with an aerodynamic diameter smaller than 2.5 μm); these are more dangerous because they penetrate more deeply into the lung and may reach the alveolar region.

The size of the particles also determines the time they spend in the atmosphere. While sedimentation and precipitation removes PM_{10} from the atmosphere within few hours of emission, $PM_{2.5}$ may remain there for days or even a few weeks. Consequently, these particles can be transported over long distances.

Principal sources

The major PM components are sulfate, nitrates, ammonia, sodium chloride, carbon, mineral dust and water. Particles may be classified as primary or secondary depending on their formation mechanism.

Primary particles are directly emitted into the atmosphere through man-made (anthropogenic) and natural processes. Anthropogenic processes include combustion from car engines (both diesel and petrol); solid-fuel (coal, lignite and biomass) combustion in households; industrial activities (building, mining, manufacturing of cement, ceramic and bricks, and smelting); erosion of the pavement by road traffic and abrasion of brakes and tyres; and work in caves and mines. Secondary particles are formed in the air, usually by chemical reactions of gaseous pollutants, and are products of atmospheric transformation of nitrogen oxides mainly emitted by traffic and some industrial processes, and sulfur dioxide resulting from the combustion of sulfur-containing fuels. Secondary particles are mostly found in the fine PM fraction.

Health hazards

The systematic data assessment completed in 2004 by the WHO European Centre for Environment and Health, Bonn, indicates that:

- PM increases the risk of respiratory death in infants under 1 year, affects the rate of lung function development, aggravates asthma and causes other respiratory symptoms such as cough and bronchitis in children;
- $PM_{2.5}$ seriously affects health, increasing deaths from cardiovascular and respiratory diseases and lung cancer. Increased $PM_{2.5}$ concentrations increase the risk of emergency hospital admissions for cardiovascular and respiratory causes; and
- PM_{10} affects respiratory morbidity, as indicated by hospital admissions for respiratory illness.

Relation of health effects to PM concentration

In the last decade, studies of the short-term effects of PM, based on association between daily changes in PM_{10} concentrations and various health outcomes, were conducted in many cities in the WHO European Region, including Erfurt and Cologne in Germany. In general, results indicate that short-term changes in PM_{10} at all levels lead to short-term changes in acute health effects (Table 1). Effects related to short-term exposure include: inflammatory reactions in the lung, respiratory symptoms, adverse effects on the cardiovascular system and increases in medication use, hospital admissions and mortality.

Table. 1. Short-term effects on health from 10-µg/m^3 increases in PM_{10} concentration

Health outcome	**Estimated percentage increase in risk per 10 µg/m^3 PM_{10} (95% confidence interval)**	**Estimates available for meta-analysis**
All-cause mortality	0.6 (0.4–0.8)	33
Mortality from respiratory diseases	1.3 (0.5–2.0)	18
Mortality from cardiovascular diseases	0.9 (0.5–1.3)	17
Hospital admissions for respiratory disease, people age 65 years and over	0.7 (0.2–1.3)	8
Cough, children aged 5–15 years with chronic symptoms	0.0 (–1.3–1.1)	34
Medication use, children aged 5–15 years with chronic symptoms	0.5 (–1.9–2.9)	31

Source: Anderson HR et al. *Meta-analysis of time series studies and panel studies of particulate matter (PM) and ozone (O_3). Report of a WHO task group*. Copenhagen, WHO Regional Office for Europe, 2004 (http://www.euro.who.int/document/e82792.pdf, accessed 8 April 2005).

Because long-term exposure to PM results in a substantial reduction in life expectancy, the long-term effects clearly have greater significance to public health than the short-term effects. $PM_{2.5}$ shows the strongest association with mortality, indicating a 6% increase in the risk of deaths from all causes per 10-µg/m^3 increase in long-term $PM_{2.5}$ concentration.[1] The estimated relative risk amounts to 12% for deaths from cardiovascular diseases and 14% for deaths from lung cancer per 10-µg/m^3 increase in $PM_{2.5}$.[2]

The effects related to long-term exposure include: increases in lower respiratory symptoms and chronic obstructive pulmonary disease, reductions in lung function in children and adults, and reduction in life expectancy, due mainly to cardiopulmonary mortality and probably to lung cancer

Studies on large populations show a strong effect of $PM_{2.5}$ on mortality, and have been unable to identify a threshold concentration below which ambient PM has no effect on health: a no-effect level. After a thorough review of recent scientific evidence, a WHO working group therefore concluded that, if there is a threshold for PM, it lies in the lower band of currently observed PM concentrations in the European Region.

Estimated change in health damage due to PM in the EU through implementation of current legislation, 2000–2020

Health end-point	Units (1000s)	2000	2020	Difference
EU				
Mortality – long-term exposure	Life years lost	3001	1900	1101
Mortality – long-term exposure	No. premature deaths	288	208	80
Infant mortality	Cases	0.6	0.3	0.3
Chronic bronchitis	Cases	136	98	37
Respiratory hospital admissions	Cases	51	33	19
Cardiac hospital admissions	Cases	32	20	12
Restricted activity	Days	288 292	170 956	117 336
Respiratory medication use, children	Days	3510	1549	1961
Respiratory medication use, adults	Days	22 990	16 055	6935
Lower respiratory symptoms, children	Days	160 349	68 819	91 529
Lower respiratory symptoms, adults with chronic disease	Days	236 498	159 723	76 773
Germany				
Mortality – long-term exposure	Life years lost	657	413	244
Mortality – long-term exposure	No. premature deaths	65	48	17

[1] Pope AC et al. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. *Journal of the American Medical Association*, 287:1132–1141 (2002).

[2] Pope AC et al. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. *Journal of the American Medical Association*, 287:1132–1141 (2002); and Pope AC et al. Cardiovascular mortality and long-term exposure to particulate matter air pollution. *Circulation*, 109:71–77 (2004).

Infant mortality	Cases	0.09	0.05	0.04
Chronic bronchitis	Cases	31	21	10
Respiratory hospital admissions	Cases	11	7	4
Cardiac hospital admissions	Cases	7	4	3
Restricted activity days	Days	63 832	36 216	27 616
Respiratory medication use, children	Days	781	324	457
Respiratory medication use, adults	Days	5166	3522	1645
Lower respiratory symptoms, children	Days	32 291	13 406	18 884
Lower respiratory symptoms, adults with chronic disease	Days	52 636	34 993	17 644

Source: Pye S, Watkiss P. *CAFE CBA: baseline analysis 2000 to 2020*. Vienna, International Institute for Applied Systems Analysis, 2005 (AEAT/ED51014/Baseline Scenarios; http://www.iiasa.ac.at/docs/HOTP/Mar05/cafe-cba-baseline-results.pdf, accessed 8 April 2005).

For more technical information contact:

TECHNICAL INFORMATION:

Dr Michal Krzyzanowski
Regional Adviser, Air Quality and Health
WHO European Centre for Environment and Health, Bonn
WHO Regional Office for Europe
Bundeshaus, Görresstraße 15
D-53113 Bonn, Germany
Tel.: + 49 228 209 4405. Fax: +49 228 209 4201
Email: mkr@ecehbonn.euro.who.int

PRESS INFORMATION:

Ms Liuba Negru
Press and Media Relations Officer
WHO Regional Office for Europe
Scherfigsvej 8, DK-2100 Copenhagen Ø, Denmark
Tel.: +45 39 17 13 44. Fax: +45 39 17 18 80
E-mail: LNE@euro.who.int

Ms Cristiana Salvi
Technical Officer, Communication and Advocacy
WHO European Centre for Environment and Health, Rome
WHO Regional Office for Europe
Via Francesco Crispi 10, I-00187 Rome, Italy
Tel.: +39 06 4877543. Mobile: +39 348 0192305
Fax: +39 06 4877599
E-mail: csa@ecr.euro.who.int