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Exposure of children to air pollution (particulate matter) in outdoor air

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Child population-weighted annual mean particulate matter (PM_{10}) concentration.

This summary is based on annual mean PM_{10} concentrations measured in urban background locations. National estimates are calculated as population-weighted means of average PM_{10} concentrations in cities. The calculations have been made with total (all age) city populations as the weighting factor in calculating the country mean indicator. This is because of the lack of children-specific data for many of the cities and on the assumption that the proportion of children in total city populations does not vary significantly between the (large) cities in each country.

KEY MESSAGE

Country average PM_{10} exposure levels varied from 13–14 µg/m^3 (Finland, Ireland) to 53–56 µg/m^3 (Bulgaria, Romania and Serbia and Montenegro (Serbia)[1]). A wide (three-fold) variation in the level of exposure of children to PM_{10} was observed in some countries.

The country average level of the indicator has not changed substantially in the last few years in most of the WHO European Region.

Most (89%) people (including children) in European cities where PM_{10} is monitored are exposed to PM_{10} levels exceeding the WHO air quality guideline level (AQG) (20 µg/m^3), giving rise to a substantial risk to children's health. For 14% of people, the European Union (EU) limit value of 40 µg/m^3 is exceeded.

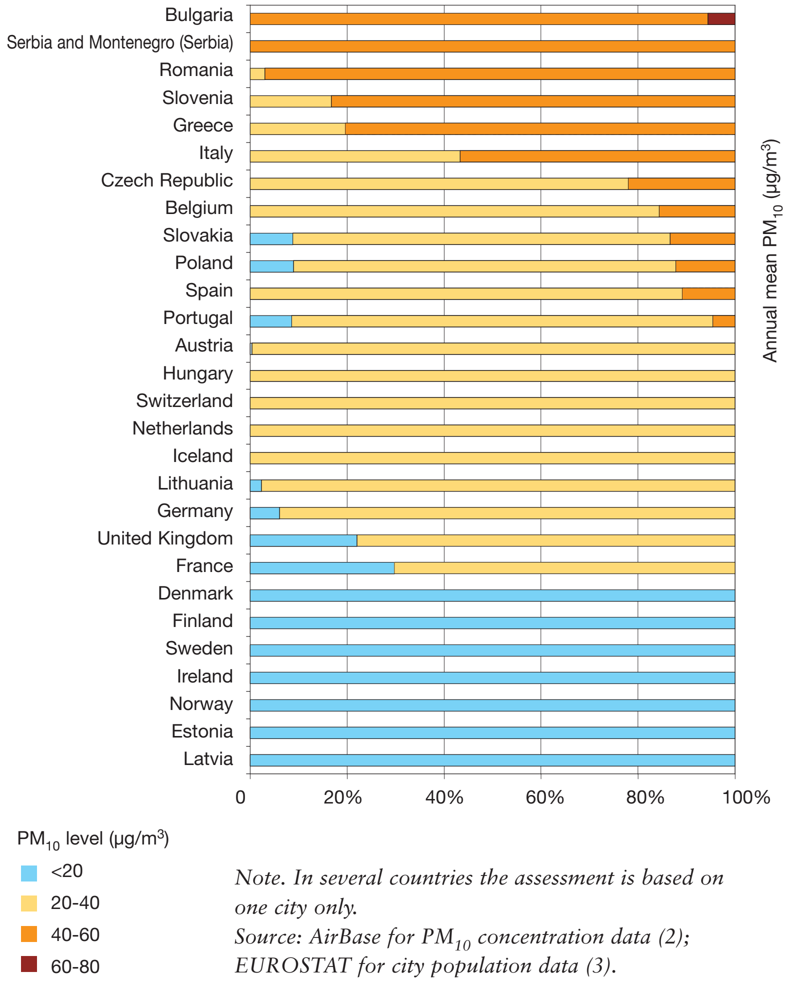
PM_{10} data from regular monitoring are not available for 31 countries (with 43% of the population) of the Region, but an approximate assessment indicates that the pollution levels and corresponding health risks may be even higher in many of these countries.

RATIONALE

Long-term average exposure to particulate matters (PM_{10}) determines both the risks of chronic effects of pollution on children's health, such as impaired development of lung function, and the frequency of acute effects, such as the aggravation of asthma or incidence of respiratory symptoms. This indicator is also well correlated with the risk of a wide range of health effects, including increased mortality, in adults. The measure of exposure combines the PM_{10} concentration and the size of the population subject to the exposure.

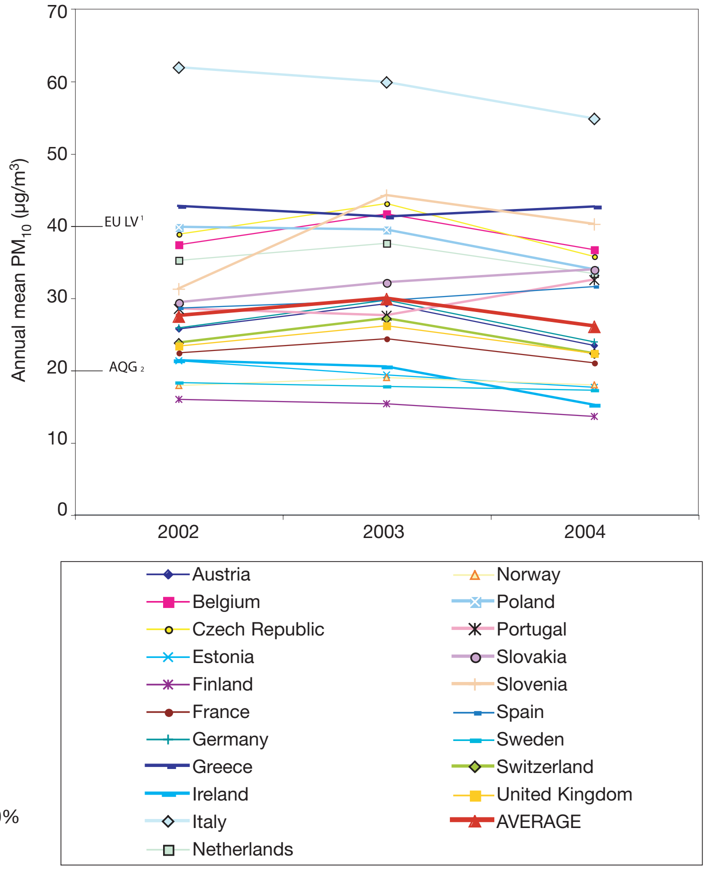
[1] *Serbia and Montenegro became two separate Member States of WHO in September 2006. In this fact sheet the data refer to before that date and relate to the then entity of Serbia and Montenegro (Serbia).*

Fig. 1. Percentage of children living in cities with various PM_{10} levels, 2004 (or last available year)



Note. In several countries the assessment is based on one city only.
Source: AirBase for PM_{10} concentration data (2); EUROSTAT for city population data (3).

Fig. 2. Changes in exposure of children to PM_{10} in cities, 2002–2004



[1] EU LV - EU limit value.
[2] AQG - Air quality guidelines.
Source: AirBase for PM_{10} concentration data (2); EUROSTAT for city population data (3).

PRESENTATION OF DATA

Figure 1 presents the total population distribution of annual PM_{10} concentrations in 2004 (or the last available year). This distribution is an approximation of the distribution of the exposure of children based on the assumption of similarity in the proportion of children in cities' populations.

Figure 2 presents population-weighted means of PM_{10} concentrations measured in the 240 cities providing PM_{10} data from the three years 2002–2004 (out of the 416 cities in Fig. 1). An increase of the mean in 2003 might be due to meteorological conditions. The AQG level for annual mean PM_{10} concentrations is exceeded in most countries, and the EU limit value is exceeded in Greece, Italy, Slovenia and (in 2003) in Belgium and the Czech Republic.

HEALTH – ENVIRONMENT CONTEXT

Very young children, probably including unborn babies, are particularly sensitive to air pollutants *(4)*. The evidence is sufficient to infer a causal relationship between particulate air pollution and deaths from respiratory complaints in the post-neonatal period. Evidence is also sufficient to infer a causal relationship between exposure to ambient air pollutants and adverse effects on lung function development. Both reversible deficits of lung function as well as chronically reduced lung growth rates and lower lung function levels are associated with exposure to particulates. The available evidence is also sufficient to assume a causal relationship between exposure to PM and aggravation of asthma, as well as the increased prevalence and incidence of cough and bronchitis.

In the light of the accumulated evidence, WHO revised its AQG for PM in 2005 *(1)*. For PM2.5, the AQG values are 10 µg/m3 (annual average) and 25 µg/m^3 (24-hour mean, not to be exceeded more than 3 days/year). For PM_{10} the corresponding values were set as 20 µg/m^3 and 50 µg/m^3. Since there are insufficient data for children, these guideline values are based on evidence emerging from studies on adults. However, reduction of exposure to AQG levels will reduce the risk of health effects in children as well as in adults.

This fact sheet focuses on PM, a type of air pollution that is present everywhere that people live and is generated to a great extent by human activities: transport, energy production, domestic heating and a wide range of industries. PM is an air pollutant consisting of a mixture of solid and liquid particles suspended in the air. These particles differ in their physical properties (such as size), chemical composition, etc. PM can either be directly emitted into the air (primary PM) or be formed secondarily in the atmosphere from gaseous precursors (mainly sulfur dioxide, nitrogen oxides, ammonia and non-methane volatile organic compounds) *(5)*. The risks from various PM have been shown to increase with exposure and there is little evidence to suggest a threshold below which no adverse health effects would be anticipated *(1)*.

POLICY RELEVANCE AND CONTEXT

There is sufficient evidence to indicate that reducing emissions of major air pollutants leads to reduced levels of particulate air pollution, population exposure and health effects.

Pan-European policy context
In 2004, the Fourth Ministerial Conference on Environment and Health adopted the Children's Health and Environment Action Plan for Europe, which includes four regional priority goals to reduce the burden of environment-related diseases in children. One of the goals (RPG III) aims to prevent and reduce respiratory diseases due to outdoor and indoor air pollution, thereby contributing to a reduction in the frequency of asthmatic attacks, and to ensure that children can live in an environment with clean air *(6)*. Reduction of exposure to PM is essential to the achievement of this goal.

The Convention on Long-range Transboundary Air Pollution can be an important instrument contributing to the reduction of air pollution and population exposure to PM *(7)*. The PM Working Group of the Convention is evaluating the degree of control of pollutants that contribute to the formation of PM, already provided for by existing protocols to the Convention and other instruments, as well as developing further technical and non-technical measures to assist Parties to reduce PM emissions and exposure.

EU policy context
The Sixth Community Environment Action Programme called for the development of a thematic strategy on air pollution with the objective of attaining "levels of air quality that do not give rise to significant negative impacts on and risks to human health and the environment". This thematic strategy on air pollution, prepared by the Clean Air for Europe programme, was adopted on 21 September 2005 *(8)*. It established interim health-related objectives for air quality in the EU and recommended that current legislation be modernized and better focused on the most serious pollutants and that more is done to integrate environmental concerns into other policies and programmes.

Council Directive 1999/30/EC of 22 April 1999 introduced the current binding limit values for PM_{10} concentrations (40 µg/m3 as the annual average and 50 µg/m^3 as the daily average not to be exceeded more than 35 days a year) *(9)*. The proposal for a directive on ambient air quality and cleaner air for Europe *(8)* includes a cap on concentrations of PM2.5 and targets for reducing the exposure of the population to PM2.5. The details of the directive are being discussed by the EU.

ASSESSMENT

Ambient PM_{10} concentrations are a good approximation of the exposure of the population to PM from outdoor sources. Numerous epidemiological studies conducted in Europe and in other parts of the world show links between various indicators of children's health and outdoor PM_{10} in concentrations currently being observed in European cities. WHO's analysis, based on data from the late 1990s, indicates that throughout the Region around 700 deaths annually from acute respiratory infections in children aged 0–4 years can be attributed to PM_{10} exposure *(10)*. The quantification of impacts of PM on morbidity is more difficult and less precise, but a preliminary analysis indicates that a reduction of exposure to PM_{10} to 20 µg/m^3 would be associated with a 7% decrease in the incidence of coughs and lower respiratory symptoms and a 2% decrease in admissions to hospital of children under 15 years with respiratory conditions *(11)*. A decrease in PM_{10} concentration of 10 µg/m^3 is expected to reduce the number of days that children aged 5–14 years suffer lower respiratory symptoms (wheezing, chest tightness, shortness of breath and cough) by 1.9 days per year per child. It is also estimated to reduce days of bronchodilator usage by 18% in children aged 5–14 years with asthma *(5)*.

The estimates of health effects of PM exposure in adults are dominated by the increase in the risk of mortality due to long-time exposure to fine PM (PM2.5) *(5)*. Current exposure to PM from anthropogenic sources leads to the loss of 8.6 months of life expectancy in Europe – from around 3 months in Finland to more than 13 months in Belgium. The total number of premature deaths attributed to exposure amounts to around 348 000 annually in the 25 EU countries.
Current legislation related to the emission of pollutants is expected to reduce impacts by around one third. Further reduction, down to around 50% of those estimated for current pollution levels, could be achieved by implementing all currently feasible emission reduction measures (the maximum feasible reduction scenario) *(1)*.

Table 1. Availability of data for the indicator RPG3_Air_Ex2_PM

All cities with data (2004 or last available)				Cities with PM10 data for 2002–2004		
	Population covered by PM data	Population covered by PM data as a percentage of total urban population (%)	No. of cities	PM10 weighted mean (µg/m^3)	No. of cities	Percentage of total population covered by PM data %
Austria	3 099 246	57.5	22	26.1	12	83.2
Belgium	3 154 722	31.1	12	35.7	6	73.2
Bulgaria	1 603 824	29.5	4	52.9	–	0.0
Czech Republic	3 575 340	47.6	27	35.1	18	83.2
Denmark	1 362 264	29.5	1	19.5	–	0.0
Estonia	434 763	46.6	1	17.6	1	100.0
Finland	1 299 967	40.7	6	13.6	6	100.0
France	17 523 354	38.0	60	20.8	55	95.0
Germany	23 330 650	37.7	111	23.5	64	87.7
Greece	3 821 970	58.6	2	40.2	2	100.0
Hungary	2 174 421	32.6	4	22.9	–	0.0
Iceland	160 594	59.2	1	29.9	–	0.0
Ireland	1 168 778	48.0	4	12.7	1	15.4
Italy	10 186 442	25.9	28	42.2	4	16.1
Latvia	47 005	3.0	1	14.3	–	0.0
Lithuania	604 300	26.4	2	23.2	–	0.0
Netherlands	1 812 839	14.0	4	33.4	4	100.0
Norway	498 980	14.1	4	16.9	1	12.0
Poland	7 212 200	30.5	31	30.6	8	53.4
Portugal	1 047 589	17.5	6	31.3	4	82.0
Romania	2 435 196	21.0	3	53.0	–	0.0
Serbia+Montenegro (Serbia)	1 168 454	–	1	55.8	–	0.0
Slovakia	1 289 422	42.6	13	34.0	4	64.5
Slovenia	324 198	31.9	3	40.2	3	100.0
Spain	5 233 274	16.0	26	32.8	15	78.3
Sweden	1 181 624	15.6	2	17.2	1	97.2
Switzerland	1 883 717	34.1	5	22.2	4	93.8
United Kingdom	23 384 335	43.6	32	22.5	27	89.4
Total	121 019 468		416		240	72.7

DATA UNDERLYING THE INDICATOR

Data source
PM_{10} data: AirBase *(2)*.
Population data: EUROSTAT *(3)*.

Description of data
PM_{10} monitoring data are submitted by national authorities to AIRBASE. Only data from urban or suburban background locations, available for at least 75% days of the year, are used. Data quality check and verification of the station's location classification are carried out by the European Topic Centre on Air and Climate Change *(12)*.

For several countries, the assessment is based on data from one, or a few, cities. In five countries, coverage of the urban population is under 20%.

Method of calculating the indicator

Exp = SUM {(Pi/P)*Ci}, where:

Ci = annual mean PM_{10} concentration in subpopulation Pi,

P = SUM (Pi), which is the total population in cities with data.

Geographical coverage

All data from cities with PM_{10} measured in urban (or suburban) background locations included in AirBase have been used for this analysis (Table 1). PM_{10} monitoring is not conducted in most of the non-EU countries, which makes it difficult to assess exposure in that part of the Region.

Period of coverage

PM_{10} data used for this analysis cover the years 2002–2004. Data from earlier years are available for a limited number of countries. For the EU countries, PM_{10} monitoring is required by the Sixth Community Environment Action Programme *(13)* and the strategy developed by the Clean Air for Europe programme, adopted in September 2005 *(8)*. This assures a continuation of monitoring and an increase in coverage of the European population.

Frequency of update

Air quality data (daily concentration of PM_{10}) are submitted by national authorities to AirBase annually. After data quality checks and data processing, the data are made available on line (with a delay of about one year).

City-specific population data are updated less frequently but, since they are used as a weighting factor only, and due to the relative stability of the spatial distribution of population in the countries, the exposure indicator is not affected by the lack of an annual update of population data.

Data quality

Quality assurance and control procedures apply to the PM_{10} data submitted to Airbase *(2)*.

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Further information

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