



EUROPEAN RESPIRATORY SOCIETY

Position Paper on the proposed EU directive on Particulate Matter. (12 April 2006)

Introduction

The European Respiratory Society (ERS) (www.ersnet.org) is a not-for-profit, international medical organisation with over 7,000 members from 100 countries and was founded in 1990. It is the largest society in Europe in its field. The main objective of the Society is to promote respiratory health in Europe in order to alleviate suffering from respiratory disease. This is accomplished by promoting basic epidemiological and clinical respiratory research, collecting and disseminating scientific information, organising congresses and conferences, producing scientific publications, supporting training and continuous education in respiratory medicine and collaborating with organisations representing patients.

Its sister organisation the *European Lung Foundation (ELF)* (www.european-lung-foundation.org) was created by the ERS in 2000 with the mission of helping the European scientific community share its expertise in respiratory medicine with the public. The *ELF* is the only pan-European foundation dedicated to lung health.

General comments

The ERS has reviewed the scientific evidence regarding the health effects of Particulate Matter (PM₁₀, particles with aerodynamic diameter less than 10 µm; and PM_{2.5}, less than 2.5 µm) also considering the recent document updating the WHO Air Quality Guidelines (WHO, 2005). The ERS has evaluated the draft of the new EU directive on air quality published on 21 September 2005 (EU, 2005).

The ERS believes that stricter legislation is needed at European level on ambient air quality and cleaner air for Europe. However, the ERS is concerned that the proposed Directive does not adequately reflect the best scientific evidence available and it is unclear how this Directive will help to achieve the objectives of reducing the health impacts of air pollution in Europe.

The ERS would like to express its concerns regarding some measures foreseen by the proposed Directive. In particular, we are concerned about the proposed limit value (or “cap”) for PM_{2.5} and about the proposed changes to already existing regulations regarding PM₁₀.

Specific comments

The ERS believes that:

- 1. The proposed PM_{2.5} “cap” annual average of 25 µg/m³ is not sufficient to adequately protect public health.**



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The proposed directive recognizes the importance of fine particulate matter and that major adverse effects on health occur in Europe today as a consequence of current exposure to PM_{2.5}. The proposed directive indicates that over the next fifteen years, all EU member states should reduce their PM_{2.5} concentrations by at least 20% unless the average level is below 7 µg/m³. We are concerned that the ‘exposure reduction’ plans in the proposed directive are not legally binding. The only legally binding instrument that is being proposed is a ‘cap’ of an annual average PM_{2.5} concentration of 25 µg/m³. This is substantially higher than level at which very significant adverse health effects have been documented by studies conducted in Europe and elsewhere. We are very concerned that the net effect of these proposals will be that most Member States will no longer be stimulated to take exposure reduction measures, as they are already below the 25 µg/m³ ‘cap’. A legally binding “cap” must be maintained and a significant reduction in its level is strongly recommended.

2. The exclusion of all ‘natural’ PM from compliance considerations in effect reduces the public health protection from PM₁₀.

The Commission proposes to allow Member States to subtract all ‘natural’ PM from compliance considerations. However, the existing limit values for PM₁₀ (1999 EU Directive) are based on the scientific findings regarding the exposure-response relationships of the health effects of particles in ambient air. These relationships have always included the “natural background” and reflect the health-damaging effects of the true measured concentrations in Europe. Also, the scientific evidence is not reassuring about the short-term health effects of coarse particles on the respiratory system (Brunekreef, & Forsberg, 2005). This new proposal would allow for higher PM₁₀ values than in the existing legislation and therefore weaken health protection.

3. New derogations for PM₁₀ attainment reduce the public health protection from PM₁₀.

The Commission’s proposal introduces new derogation possibilities that would allow Member States to delay reaching the legally binding limit values by up to five years. This would apply to the limit values which already entered into force in 2005 (PM₁₀) as well as to the limit values, which are to enter into force in 2010 (PM_{2.5}). In effect, this will weaken the already agreed and adopted air quality legislation and will contribute to eroding EU’s credibility in firm implementation of common legislation.

In conclusion, the ERS is concerned that the proposed Directive does not adequately reflect the best scientific evidence and it is unclear how this Directive will help to achieve the objectives of reducing the health impacts of air pollution in Europe. In the face of the extensive evidence on PM and health, WHO has recently introduced a new, stricter air quality guideline of 10 µg/m³ for PM_{2.5} (WHO, 2005). In the U.S., the American Thoracic Society and other health organisations have recommended to promulgate National Ambient Air Quality Standards (NAAQS) for particulate matter (PM) that protect the public health with “an adequate margin of safety” (Rom and Samet, 2006). It is clear that there is a sound scientific basis for a restrictive regulation of PM₁₀ and PM_{2.5}, with regard both the short-term (24-hour) and long-term (annual) limit values.



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Furthermore, the ERS believes that the next 7th EU Framework Programme on Research and Development should provide the needed resources for continuing study of the effects of air pollution on respiratory health in European and elsewhere.

The scientific evidence on air pollution and health effects

Long-term exposure to particulate air pollution augments the risk of chronic diseases, e.g. chronic obstructive pulmonary disease (COPD), atherosclerosis and cancer, resulting in an increase in pre-term mortality. Short-term peaks in particulate air pollution are associated with an aggravation of clinical cardiovascular and respiratory conditions especially among already frail individuals.

The initial suggestion that mortality increases due to long term, low level exposure to PM was provided by the Harvard Six Cities study (Dockery et al., 1993), which estimated the adjusted mortality-rate ratio for the most polluted of the cities as compared with the least polluted, 1.26 (95 percent confidence interval, 1.08 to 1.47) (range of PM_{2.5} from 11.0 to 29.6 µg/m³). Confirmation of the findings has been shown in the long term follow-up (from 1982 to 1998) of the American Cancer Society cohort, approximately 500 000 adults from the metropolitan areas throughout the United States (Pope et al., 1995, 2002). Each 10 µg/m³ elevation in PM_{2.5} was associated with approximately a 6%, 9%, and 14% increased risk of all-cause, cardiopulmonary and lung cancer mortality, respectively. The range of PM_{2.5} values in this study was from 9 to 33.5 µg/m³, initially, decreasing to 5 – 20 µg/m³ at the end of follow-up. A recent report from Los Angeles (Jerrett et al., 2005), that included a large proportion of the ACS cohort from that area, has indicated that a more refined method for assessing exposure produces a higher risk estimate of mortality increase (17% increase, 95%CI= 5-30%) for an increase of 10 µg/m³ PM_{2.5}. Well conducted cohort studies in Europe, which have estimated air pollution exposure at individual residences, confirm the findings from U.S and indicate that air pollution including particulate matter emitted from road traffic is of greatest concern (Hoek et al., 2002; Nafstad et al., 2004; Filleul et al. 2005). The evidence of chronic effects has been accumulated for morbidity data, which indicate respiratory effects of long term exposure, a decrease in lung function and signs of atherosclerosis progression (Brauer et al., 2002; Janssen et al., 2003; Pénard-Morand et al. 2005; Kuenzli et al., 2005).

Epidemiological studies since the 1990s have analysed the variations of daily mortality and hospital admissions in relation to daily variations in particulate matter. In several cities throughout the world, consistent associations have emerged between daily mortality and ambient concentration of PM during the same or the previous few days. The final results of two collaborative projects conducted in 90 cities in the US (NMMAPS), and in 29 cities in Europe (APHEA-II) have confirmed the preliminary results. In the American cities, where annual average concentrations of PM₁₀ ranged between 23 and 46 µg/m³, a 0.27% increase in total mortality and a 0.69% increase in cardiorespiratory mortality per 10 µg/m³ PM₁₀ [at a 1-day lag](#) were detected (Dominici et al., 2002). There was no evidence of a threshold and the effects were linear even at low levels of concentration. In the European study, based on the most extensive database available in Europe and covering a large range of PM₁₀ concentrations, the risk



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estimate for overall mortality was 0.6% per 10 $\mu\text{g}/\text{m}^3$ PM_{10} (Katsouyanni et al., 2001) and 0.76% per 10 $\mu\text{g}/\text{m}^3$ PM_{10} for cardiovascular mortality (Analitis et al., 2006). Both multicity studies indicate that the cumulative effect over few weeks is much larger than what is detected with a short lag of few days. In Europe, large national studies are available from Spain (Ballester et al., 1999), the Netherlands (Hoek et al., 2000), France (Zeghnoun et al., 2001), and Italy (Biggeri et al., 2001) showing similar results.

Short-term effects on respiratory diseases have been detected in both children and adults (Brunekreef & Holgate, 2002). However, recent evidence has indicated that the effects on the cardiovascular system are of key importance, and the involvement of the heart may be crucial in the risk of death associated with air pollution among COPD patients. Recent studies have shown that sudden cardiac death and myocardial infarction could be triggered by particulate air pollution in the general population (Peters et al., 2001; Peters et al., 2004; Forastiere et al., 2005) and among people who already suffered a myocardial infarction (von Klot et al., 2005).

Substantial scientific support of the epidemiological findings comes from clinical and toxicological studies.

Reviews of the mechanisms of lung injury caused by particles, in particular among people with COPD, have proposed that particulate matter induces oxidative stress in the airways (MacNee & Donaldson, 2003; Kelly, 2003). The oxidative stress mediated by particles may arise from the direct generation of reactive oxygen species from the surface of particles or from soluble compounds such as transition metals or organic compounds (polyaromatic hydrocarbons) (Risom et al., 2005). In airways already affected by chronic inflammation, oxidative stress might up-regulate redox sensitive transcription factors (nuclear factor kappa B, NF- κ B) in airway cells thus increasing the synthesis of proinflammatory cytokines that triggers inflammation and later, cell and tissue injury (Roberts, 2003). In healthy and asthmatic volunteers, airborne particles increased bronchial responsiveness, airway resistance, and bronchial tissue mast cell, neutrophil, and lymphocyte count (Holgate et al., 2003).

Clinical, epidemiological and toxicological studies suggest several possible pathways by which inhaled noxious particles can induce cardiovascular effects (Brook et al., 2004). Firstly, PM may affect the autonomic control of the heart. Oxidative stress appears to alter the sympathetic and parasympathetic tone that affects heart rate and heart rate variability. Epidemiologic studies have associated air pollution with increased heart rate (Peters et al., 1999; Pope et al., 1999), and decreased heart rate variability (Liao et al., 1999; Pope et al., 1999; Gold et al., 2000; Park et al., 2005), both risk factors for severe arrhythmia and mortality. Among patients with implanted cardioverter defibrillators, exposure to $\text{PM}_{2.5}$ increases the risk of a ventricular tachyarrhythmia, especially in patients with increased ventricular electrical instability (Dockery et al., 2005). Secondly, oxidants can increase the level of blood coagulability and modify the adhesive properties of red blood cells, thus leading to increased risk of ischemic damage in individuals with poor coronary circulation (Seaton et al., 1999). An acute systemic response of increased synthesis of C-reactive protein, which is a known cardiovascular risk factor in healthy subjects, has been observed following exposure to PM (Peters et al., 2001). Finally, systemic



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microvascular dysfunction, which is usually associated with cardiovascular diseases, may be affected by PM exposure (Nurkiewicz et al., 2004). Also of note is a recent long-term animal study that has provided striking new evidence regarding the chronic cardiac responses to fine particles as well as on the development of atherosclerosis, thus giving strong biological support to the epidemiological findings that associate particulate matter with cardiovascular mortality (Sun et al., 2005). In this study, animals were exposed to concentrated airborne particles for 6 months, 6 hours per day, 5 days per week. The average PM_{2.5} concentration the animals were exposed to was only 15 µg/m³. A recent long-term animal study from Sao Paolo, Brazil, has shown similar results (Lemos et al., 2006). In this study, experimental animals were exposed to city air pollution at a traffic-exposed site; control animals were exposed to filtered air.

Finally, evidence has accumulated from studies in Dublin (Clancy et al., 2002), Switzerland (Bayer-Oglesby et al., 2005) and Germany (Heinrich et al. 2000, 2002) that reductions in air pollution and particulate matter is clearly associated with a reduction in the health effects. A recent report from the US indicated that mortality from natural causes decreased following reductions in PM_{2.5} concentration in the six-city study that originally suggested chronic effects of air pollution (Laden et al., 2006). The magnitude of general and susceptible populations that would benefit from more stringent PM standards would be large (Johnson & Graham, 2005).

To summarize, there is strong evidence of a causal relationship between PM exposure and negative health effects. There is broad range of effects, in the respiratory and the cardiovascular systems, involving infants, children, adults, elderly, and unhealthy subjects. In general, the risk increases linearly with exposure and no evidence has been found of a threshold below which no health effects occur. A large impact on the population has been predicted, and there are already good indications that a decrease in exposure is associated with an improvement in population health. The natural implication for the European Member States is that both short-term (24-hour) and long-term (annual) limit values are needed for both of the PM indicators. The choice of indicators should be based on the scientific evidence and protection of the public should be the priority. The evidence reflects the need for strong and rapid implementation of policies that reduce exposure to particulate matter in all but the cleanest areas of Europe. The Clean Air For Europe (CAFÉ) cost benefit analysis supports that the monetarized benefits of further reduction of PM pollution in Europe by far outweigh the cost needed for taking abatement measures.

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