Supporting paper to COMEAP 2010 report:
"The Mortality Effects of Long Term Exposure to Particulate Air Pollution in the United Kingdom"

PREVIOUS UK ESTIMATES OF THE IMPACT OF LONG-TERM EXPOSURE TO FINE PARTICLES

COMEAP Secretariat

Previous UK estimates of the impact of long-term exposure to fine particles

The 1998 COMEAP Report

The Department of Health's Committee on the Medical Effects of Air Pollutants (COMEAP) estimated in its 1998 report that, in urban areas of Great Britain, 8,100 deaths were brought forward by short-term exposure to particulate matter air pollution measured as PM_{10}[1]. This was a seminal report that quantified the effects of air pollution in the UK for the first time (Department of Health (DH), 1998); however, it was based on 1996 concentrations of PM_{10}, and levels have fallen since then.

In the 1998 report, COMEAP considered it was likely that long-term exposure to air pollutants also damaged health. However, there were no UK cohort studies to allow quantification of these effects and at that time COMEAP was reluctant to apply estimates of concentration-response coefficients from long-term studies conducted elsewhere, for the quantification of effects in the UK. It was noted that if such coefficients did apply in the UK, the overall impact of air pollution on mortality might be substantially greater than those that COMEAP had been able to quantify.

The 2001 COMEAP report

In 2001, COMEAP published a report on the 'Long-term Effects of Particles on Mortality' which quantified the effects and in particular the loss of life expectancy, which could result from long-term exposure to particles. In that report, COMEAP considered a range of coefficients from 1% to 9% for a 10 $\mu g/m^3$ reduction in $PM_{2.5}$[2], derived from the American Cancer Society (ACS) study (Pope *et al*, 1995) and the Health Effects Institute (HEI) reanalysis of the ACS study and the US Six-Cities Study (HEI, 2000). $PM_{2.5}$ is defined in the same manner as PM_{10} but with an aerodynamic diameter of 2.5 µm. COMEAP (DH, 2001) regarded the 1% coefficient as the most likely effect estimate and 9% as implausibly large. This report included a rough estimate that, using the 1% coefficient, the effects of long-term exposure were about ten-fold greater, on a years-of-life-lost basis (i.e. in terms of average life-shortening), than the effects of short-term exposure.

As importantly, the COMEAP report (DH, 2001) described and used a methodology, based on life tables, for linking the risk coefficients of concentration-response functions with demographic information in England and Wales to estimate the life expectancy benefits of reducing UK concentrations of annual average $PM_{2.5}$.

Specifically, COMEAP (DH, 2001) estimated the effects of a 1 $\mu g/m^3$ decrease in annual mean $PM_{2.5}$ levels on the population of England and Wales. The Committee used coefficients ranging from 1% - 9% (decrease in hazard rate) for a 10 $\mu g/m^3$ reduction in $PM_{2.5}$ with assumptions about a lag time (i.e. the time between a reduction in pollution and the consequent reduction in risks of mortality) varying from an immediate effect to a step change after a delay of 40 years. It was estimated that the population alive in 2000 would in total live between 0.2 and 4.1 million years

[1] PM_{10} is defined as the mass per cubic metre of particles passing through the inlet of a size selective sampler with a transmission efficiency of 50% at an aerodynamic diameter of 10 µm.
[2] $PM_{2.5}$ is defined as the mass per cubic metre of particles passing through the inlet of a size selective sampler with a transmission efficiency of 50% at an aerodynamic diameter of 2.5 µm.

longer, per 1 µg/m^3 reduction in $PM_{2.5}$; it was unclear how this overall gain was distributed across the population.

Recent estimates

Since 2001, the evidence base regarding the effects of long-term exposure to air pollutants on mortality has strengthened considerably. Last year (2009) COMEAP published its report 'Long-term Exposure to Air Pollution: Effect on Mortality'. This report summarised the new evidence and recommended, as a best estimate for mortality in the UK, the higher risk coefficient of 6% change in risk of death from all-causes with a 10 µg/m^3 change in $PM_{2.5}$ derived from the extension of the ACS study (Pope *et al*, 2002). Risk coefficients linking $PM_{2.5}$ with specific causes of death were also recommended. The evidence for effects of long-term exposure to sulphur dioxide, nitrogen dioxide, carbon monoxide and ozone on mortality was also assessed but was judged to be weaker than that regarding particles and insufficient to justify quantification, either in place of, or in addition to, the mortality effects of long-term exposure to $PM_{2.5}$ (COMEAP, 2009).

Using COMEAP's recommended coefficient (6% increase in risk of death from all-causes per 10 µg/m^3 increase in $PM_{2.5}$), the Interdepartmental Group on Costs and Benefits (IGCB) estimated in 2007 that fine particulate air pollution reduced life expectancy from birth in the UK by an average of 7-8 months, with estimated equivalent costs of between £8.5 billion and £20.2 billion per annum (Department For Environment, Food and Rural Affairs (Defra), 2007). These calculations were based on estimates of anthropogenic fine particulate air pollution ($PM_{2.5}$) in the UK in 2005.

By 2020, after reductions in $PM_{2.5}$ due to the measures set out in the 2007 Air Quality Strategy (Defra, 2007), and other measures already agreed, the revised expected reduction in life expectancy in the UK was expected to be around 5 months (an increase in life expectancy of 2-3 months), with an associated monetary value of between £5.7 billion and £13.4 billion per annum. The monetary benefit of the agreed and proposed measures was thus expected to be about £2.8 to £6.8 billion per annum.

In 2010, Defra published 'Air Pollution: Action in a changing climate' (Defra, 2010a), containing updated values for loss of life-expectancy and costs based on anthropogenic $PM_{2.5}$ levels in 2008 rather than in 2005. The loss of life-expectancy due to $PM_{2.5}$ at 2008 levels was estimated at about 6 months, with estimated equivalent costs in 2005 prices of between £7.7 billion and £16.9 billion per annum. Details of this and associated calculations are on the IGCB website (Defra, 2010b).

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