

## Press dossier

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# The public health benefits of reducing air pollution in the Barcelona metropolitan area

In the last decade, numerous studies conducted in animals and human populations have confirmed that exposure to current levels of ambient man-made air pollution lead to a wide range of adverse health effects, including diseases and death. More recent research suggests that pollutants emitted by cars and trucks to be of particular health concern. A few studies even show that morbidity and mortality promptly decreased in areas where air quality improved.

Despite open research questions, the amount of information has become large enough to approximately quantify the burden of health problems that can be attributed to ambient air pollution in a given region, country, or city. Such risk assessment –or the translation of research findings into a quantifiable public health burden– is an important tool to inform policy makers and the public about the size of the current problem and, thus, about the potential public health benefits of air pollution regulations.

Air quality measurements in recent years revealed high levels of pollution in many urban areas of the world (Figure 1). In the city of Barcelona and adjacent municipalities, compounds related to emissions from traffic, industries and from the activities of the airport and harbor have been shown to be of particular concern. For example, inhalable particulate matter (PM<sub>10</sub>), the tiny particles of solid or liquid origin suspended in the air of size of 10 micrometres or less, and the gas nitrogen dioxide (NO<sub>2</sub>), both originated mainly from traffic, regularly exceed current standards set to protect health.<sup>1</sup>

The Generalitat de Catalonia has recently approved a plan to improve air quality in those areas of Catalonia with the highest concentrations of pollution. The first step is the implementation of a mitigation plan for the Barcelona metropolitan area<sup>2</sup>. The goal of this plan is to reduce by 2010 air pollution in the area to comply with the current standards legislated in the European Union (EU).

The objective of this study developed by the Centre de Recerca en Epidemiologia Ambiental (CREAL) and commissioned by the departaments of health and the environment (Departament de Salut i de Medi Ambient i Habitatge) of the Generalitat de Catalunya, was to estimate the health benefit that is expected to result from a reduction of air pollution in the Barcelona metropolitan area. Existing worldwide research suggests that adverse effects of ambient pollution occur already at very low levels with no evidence for any threshold of no effect. As a consequence, any improvement of air quality leads to some health benefits, and – vice

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<sup>1</sup> [http://mediambient.gencat.net/cat/el\\_medi/atmosfera/immissions/](http://mediambient.gencat.net/cat/el_medi/atmosfera/immissions/)

<sup>2</sup> Mitigation plan approved by the Decree 152/2007 and associated to the Decret 226/2006: "declaració de les zones de protecció especial de l'ambient atmosfèric pels contaminants diòxid de nitrogen i partícules en suspensió, corresponent a diferents municipis de les comarques del Barcelonès, el Vallès Oriental, el Vallès Occidental i el Baix Llobregat".

versa – a further deterioration of air quality in Barcelona will further increase the current health burden attributable to pollution. Thus, to quantify the benefits of pollution abatement strategies one has to compare the current burden with the one expected if air quality was at some lower levels.

This project chose two lower levels to quantify the health impact of air pollution. The first calculations estimate the health benefit of the air pollution management plan of the Generalitat de Catalunya to achieve the current EU air quality standards.

As shown in many regions and countries, sustained mitigation plans result in lasting trends of air quality improvements. Thus, our second scenario quantifies the annual health benefit assuming pollution is further decreased to comply with the annual mean level proposed by the World Health Organization (WHO) to protect the health of people.

## Methods used to calculate health benefits

The method used to estimate the health benefits of the two scenarios is based on standard approaches to derive the number of adverse effects that are attributable to some established risk factor. These methods are needed as it is not possible to directly observe or count the number of health problems due to risk factors such as smoking, diet, or air pollution. The calculation requires three basic information, namely 1) the current total frequency or occurrence of a health problem in the population, 2) the current level of pollution and the expected future level to derive the *change* in the concentrations that people are exposed to, and 3) the quantitative information about the association between exposure to air pollution and the occurrence of health outcomes.

*Selected health problems:* The CREAL study focused the evaluation on three main types of health outcomes relevant for individuals and health authorities in terms of severity and burden that they represent: mortality, morbidity including chronic bronchitis and asthma related symptoms, and health care use represented by hospital admissions for cardiovascular and respiratory diseases. The same health outcomes have been used in other European and United States risk assessment studies in the last few years.

*Selected pollution:* While air pollution consists of a complex mixture of hundreds of toxic constituents, risk assessments cannot be conducted for each substance one by one. The most useful approach is to use a marker of urban air pollution, and most risk assessments use ambient particulate matter (PM) to describe the burden of pollution and the benefits of regulations. This project is also based on PM, namely on PM<sub>10</sub>. Benefits were obtained comparing levels of PM<sub>10</sub> to which the population is currently exposed to the expected levels after reduction of pollution. The current average population exposure to PM<sub>10</sub> was estimated to be around 50 µg/m<sup>3</sup>, estimated for 57 contiguous municipalities around the municipality of Barcelona and totaling a population of nearly 4 millions inhabitants. Thus, the CREAL study quantifies the benefit of the current PM<sub>10</sub> population mean exposure concentration being decreased by approximately 10 µg/m<sup>3</sup> to meet

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the current EU PM<sub>10</sub> standard of 40 µg/m<sup>3</sup> annual mean, and decreased by approximately 30 µg/m<sup>3</sup> to meet with the recommended WHO standard of 20 µg/m<sup>3</sup> annual mean for PM<sub>10</sub>.

*Monetary value of the benefits:* Given that societies have limited resources to allocate to projects and policies, a transformation of health benefits into monetary values is often welcomed by policy makers and the public. These costs may then be directly compared to costs of mitigation investments. Based on such evaluations, the United States Environmental Protection Agency concluded few years ago that one of the most efficient regulations they ever proposed was the one targeting air quality. The total investments to improve air quality were estimated to be far smaller than the benefit for the society.

### Benefits obtained

#### *Benefits of complying with the current EU air quality standard*

The CREAL study found that the annual death toll in the Barcelona metropolitan area could be lowered, on average, by approximately 1,200 deaths per year (about 4% of all natural deaths among people 30 years and older) if average annual levels of outdoor PM<sub>10</sub> were reduced to 40 µg/m<sup>3</sup> as legislated in the EU, representing a five months increase of the life expectancy. In addition to reduction in death rates, it was estimated that this reduction in air pollution could result in a total of 600 fewer hospitalizations for cardio-respiratory diseases per year, a total of 1.900 fewer cases of chronic bronchitis among adults, a total of 12,100 fewer cases of acute bronchitis among children, and 18,700 fewer asthma attacks every year in children and adults. The study found that the health burden listed above could translate to average costs ranging between approximately 300 and 600 € per person per year depending on the approach selected, or an average total between 1.100 and 2.300 million € per year. The highest estimates are based on the approach used most often so far while the lower estimate originates from revised methods proposed by the Clean Air For Europe (CAFE) program. The objective of CAFE is to develop a long-term, strategic and integrated policy advice to protect against significant negative effects of air pollution on human health and the environment in Europe.

#### *Benefits of complying with the PM<sub>10</sub> standard proposed by WHO*

Meeting with EU regulated levels by 2010 is a first step in a long-term strategy required to meet more stringent standards such as not to exceed 20 µg/m<sup>3</sup> PM<sub>10</sub> as the annual mean. The study found that reducing current levels of air pollution to the WHO standards would result in obtaining health and cost benefits nearly **three** times greater than those listed above. Thus, reducing annual air pollution levels to WHO standards would result in about 3,500 fewer annual deaths (about 12% of all deaths among people 30 years and older). This represents about 14 months increase of the life expectancy. To put this in context, the life expectancy in Catalunya at birth was 80.75 years in 2004 while it was more than one year inferior in the year

1997<sup>3</sup>. In addition to the reduction in death rates, it was estimated that this reduction in air pollution could result per year in a total of 1,800 fewer hospitalizations for cardio-respiratory diseases, a total of 5,100 fewer cases of chronic bronchitis symptoms among adults, a total of 31,100 fewer cases of acute bronchitis among children, and a total 54,000 fewer asthma attacks every year among children and adults. The monetary valuation shows that these health benefits could translate approximately to 700 and 1,600 Euros per person per year depending on the approach selected, or an average total of 3,000 and 6,400 million Euros per year, with an uncertainty range around these two estimates largely overlapping.

### Interpretation of the CREAL findings

Evidence of the role of air pollution in causing adverse health effects and death is very strong with hundreds of studies conducted all over the world including many studies in Barcelona. The CREAL study suggests substantive impact of air pollution on public health as well. Although a comparison of the societal cost is inappropriate due to the difference in age of the subjects affected, one should remember that there were a total of 549 deaths in all Catalunya due to car accidents in 2005<sup>4</sup>. However, in contrast to events such as deaths due to traffic accidents, the air pollution impact cannot be directly counted and the quantification of this impact could only be roughly approximated. This evaluation project avoided using assumptions that may have *overestimated* results. As a consequence, it is likely that the overall benefits of reducing air pollution have been underestimated.

The results obtained in the CREAL study are *estimates* that come with uncertainties intrinsic to this type of evaluation. The uncertainty range presented in this study includes the one observed in the quantitative association between PM<sub>10</sub> and health and, when considering all outcomes, averages approximately 50% around the estimates. Although less large and difficult to quantify due to lack of information, other data used in the calculations come with inherent uncertainties as well, such as the distribution of PM<sub>10</sub> concentrations across the region or the frequency of health outcomes (e.g. symptoms) which are estimates based on surveys.

Methods are currently developed to express uncertainty in a more integrated manner. However, as mentioned above, the project gives an incomplete assessment, thus benefits are most likely larger than expressed herein. Further research will lead to more complete risk assessments including, for example, a better understanding of the chronic effects of air pollution, and specifically chronic effects related to traffic emissions, the main contributor to poor air quality in the Barcelona metropolitan area.

Some strategies to abate pollution lead to very immediate and sustained improvements in air quality. The question then is whether health benefits will be immediate as well. A recent intervention study showed immediate and sustained reductions in mortality rates following the ban of coal use in the city of Dublin. Similarly, symptoms in children

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<sup>3</sup> <http://www.idescat.net/>

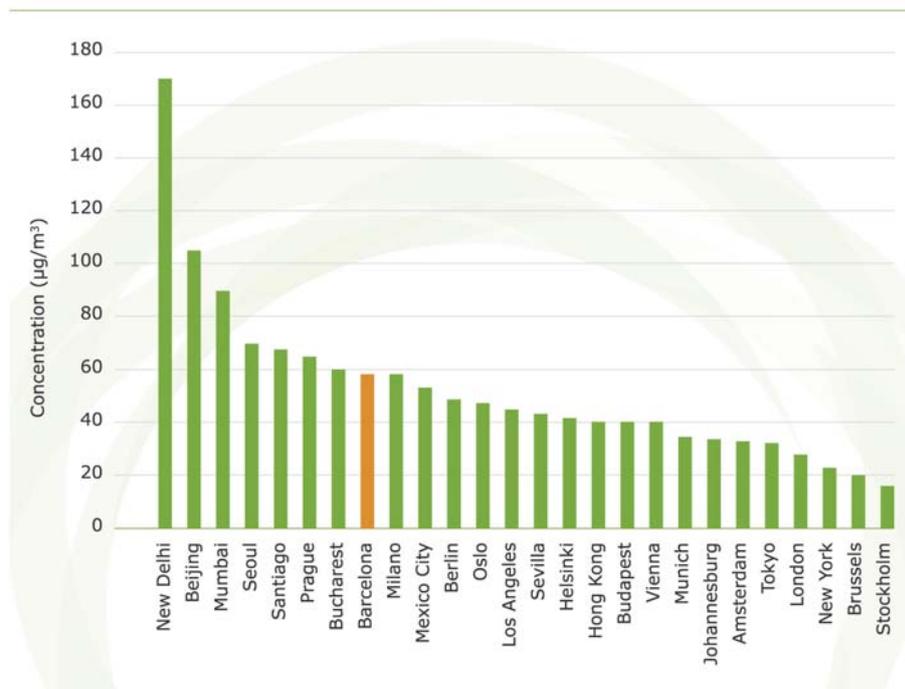
<sup>4</sup> [http://www.gencat.net/transit/pdf/cat\\_acc\\_2005.pdf](http://www.gencat.net/transit/pdf/cat_acc_2005.pdf)

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have been shown to improve if air pollution declines. However, it is reasonable to expect that not all benefits of improved air quality will immediately be detectable. In general, acute effects of pollution (e.g. hospitalizations) are expected to be reduced in parallel to the improvements of air quality but a reduction of chronic effects (e.g. decrease in the rates of new cases of lung cancer, asthma, or chronic obstructive pulmonary diseases) of air pollution may take longer to materialize.

**In summary, the CREAL study shows that decreasing PM<sub>10</sub> levels in Barcelona to 40 µg/m<sup>3</sup> –the 2010 target of the mitigation plan of the Generalitat– would lead to substantial health benefits. The health benefits for the Barcelona metropolitan area are expected to be three times larger once in compliance with the level proposed by the WHO to protect public health.**

**Figure 1. Annual average PM<sub>10</sub> concentrations observed in selected cities worldwide**



Source: World Health Organization. Air Quality Guidelines. Global Update 2005.

Table 1. Expected annual health benefits per year for a reduction of PM<sub>10</sub> annual mean in Barcelona metropolitan area

Outcome	Applicable age	Health benefits (% total cases) * for decrease of PM <sub>10</sub> , annual mean concentration of 50 µg/m <sup>3</sup> , to		
		European Community standards (Annual mean PM <sub>10</sub> = 40 µg/m <sup>3</sup> )	WHO standards (Annual mean PM <sub>10</sub> = 20 µg/m <sup>3</sup> )	
<b>Mortality</b>				
Total long-term death (include estimates for immediate acute deaths)	All causes	≥30	1,200 (4%)	3,500 (12%)
Immediate acute death of wich	All causes	All	180 (0,6%)	520 (2%)
	Cardiovascular	All	90 (0,9%)	250 (3%)
	Respiratory	All	40 (1,3%)	120 (4%)
Infant deaths	All causes	<1	5 (4%)	15 (13%)
<b>Hospital admissions</b>				
	Cardiovascular	All	210 (0,6%)	620 (2%)
	Respiratory	All	390 (1,1%)	1,150 (3%)
<b>Morbidity</b>				
Chronic diseases	Chronic bronchitis adults	≥25	1,900 (9%)	5,100 (25%)
	Acute bronchitis children	<15	12,100 (19%)	31,100 (49%)
Asthma related symptoms	Asthma attacks adults	≥15	14,700 (4%)	41,500 (11%)
	Asthma attacks children	<15	4,000 (4%)	12,400 (11%)
<b>Gain in life expectancy</b>				
	Months	≥30	5	14
<b>Range of average costs</b>				
	Total in million euros	--	1,100-2,300	3,000-6,400
	Per capita in euros	--	300-600	700-1,600

\* Uncertainty around the estimates presented is in average +/-50%.

The complete report and additional information related to the study can be downloaded from the following websites: [www.creal.cat](http://www.creal.cat), [www.imim.es](http://www.imim.es) and [www.gencat.net](http://www.gencat.net)

