BILBAO CITY REPORT

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BILBAO CITY REPORT PLAN

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BILBAO CITY REPORT

Summary of the main findings

In 2002 PM_{10} annual mean (SD) was 32.2 (16.9) µg/m^3, above the 1999/30/EC Directive limit for 2010 (20 µg/m^3), and below that established for 2005 (40 µg/m^3).

Both short and long term effects of PM_{10} have been assessed. As short term effects are concerned, in 2002 daily PM_{10} levels above 20 µg/m^3 would have triggered 127 respiratory and cardiac hospital admissions, and brought forward 67 deaths. Long term effects are an order of magnitude larger. If annual mean of PM_{10} were reduced to 20 µg/m^3, 584 deaths/year would be delayed and, approximately, 2700 years of life saved, what would imply an increase in lifetime expectancy of 0.9 years at the age of 30.

Background

The Greater Bilbao Area (Basque Country, Northern Spain) has approximately 890000 inhabitants and it is made up of Bilbao and neighbouring municipalities at both banks of the Nervion River, overlooking the Bay of Biscay. Its industrialisation, based mainly on the iron and steel sector, began at the end of the 19th century and experienced rapid growth during the decade of the 60s. In 1977 the area was declared 'Air Polluted Area' and a Cleaning-up Plan, aimed mainly at reducing industrial emissions, came into force. The measures taken included financial aids, introduction of new cleaner technology, and changes in processes and fuels. In the 90s pollution levels decreased dramatically, and in 2000 the suspension of the 'Air Polluted Area' was approved.

The first health impact assessment of suspended particles was carried out in 2001, and its results were included in the 2nd year report of Apheis. The available indicator of suspended particles was Black Smoke (BS) and only short term effects could be evaluated because relative risk (RR) for long term effects on mortality is lacking. The annual number of deaths brought forward by daily BS levels higher than 20 µg/m^3 was 11.1 (CI: 5.5-14.7), the number of attributable cardiac hospital admissions 10.4 (CI: 3.8-16.9) and the correspondent for respiratory admission among those over 65 years old 1.1 (CI: 0.0-9.2).

Within the second year of Apheis a survey was carried out to identify the information and communication needs of Municipalities of the area and Departments of the Basque Government. The response rate of those surveyed was high. The answers showed a moderate interest in the evaluation of the health effects of air pollution.

In the 3rd year, the aim of Apheis has been to evaluate the effects of suspended particles on health, including both short and long term effects. The municipalities included in the 3rd year evaluation have been Bilbao, Getxo, Barakaldo, Erandio, Leioa, Portugalete, Sestao and Santurtzi, with a total population of 708395 inhabitants (19.3% older than 65 years). The best estimates of exposure to suspended particles available when this work was carried out were PM_{10} from 2002. $PM_{2.5}$ data are still lacking in the Greater Bilbao area.

Sources

Although, in the past, industry was the most important source of air pollution with very high levels of SO_2, since the 90s traffic has become a very important source in the Metropolitan Area of Bilbao.

Exposure data

In the Metropolitan Area of Bilbao the pollution indicators are measured by an automatic network managed by the Environment Department of the Basque Government and a manual network managed by the Public Health Direction.

PM_{10} data come from the automatic network and fulfil Apheis Guidelines on Exposure Assessment. The data are from year 2002, first year measuring PM_{10} in a representative number of monitoring stations. Four urban monitoring stations of PM_{10} were available, which are representative of the whole area. The PM_{10} daily exposure indicator has been calculated as the arithmetic mean of the daily concentrations of the stations. The analytical method used is β radiation absorption in all the monitoring stations and the probe temperature 45ºC. BS data, coming from 6 monitoring stations of the manual network, are from 2002. The method used was Reflectometry (EEL reflectometer and Whatman No. 1 filter paper). $PM_{2.5}$ data are still lacking in the Greater Bilbao area.

A correction factor of 1.2 (value from a local study) has been used to compensate losses of volatile particulate matter for automatic measure of PM_{10}. $PM_{2.5}$ data, needed for the long-term health impact assessment, were calculated using PM_{10} data and a default conversion factor of 0.7. Data presented in this report are those given by the monitoring network, i.e. not corrected. Corrected values were used only for assessing the long term effects because the RR was established assessing exposure with a gravimetric method.

Exposure data for Apheis 3:

- Year of air pollution data: 2002.
- Daily mean levels (SD) of BS were 13.09 (6.44) $\mu g/m^3$.
- P_5 and P_{95}: The levels of BS reached during the 18 days with the lowest (5^{th} percentile) and the highest (95^{th} percentile) levels were respectively 6.33 $\mu g/m^3$ and 25.57 $\mu g/m^3$.
- Daily mean levels (SD) of PM_{10} were 36.2 (16.9) $\mu g/m^3$.
- P_5 and P_{95}: The levels of PM_{10} reached during the 18 days with the lowest (5^{th} percentile) and the highest (95^{th} percentile) levels were respectively 16.1 $\mu g/m^3$ and 69.5 $\mu g/m^3$.
- Number of days when air pollutants exceeded limit levels:

Table 1. Number of days when air pollutants exceeded limit levels

	Short term	
Air pollutant	PM_{10}	BS
Number of days above	20 $\mu g/m^3$	20 $\mu g/m^3$
	313	47
Number of days above	50 $\mu g/m^3$	50 $\mu g/m^3$
	69	0

The figures 1-2 show the distribution of BS and PM_{10} for the whole year. Values for BS in winter are only slightly higher than in summer. There was not any difference between winter and summer daily PM_{10} levels, 19% of which were above 50 µg/m^3.

Figure 1: Distribution of black smoke - year

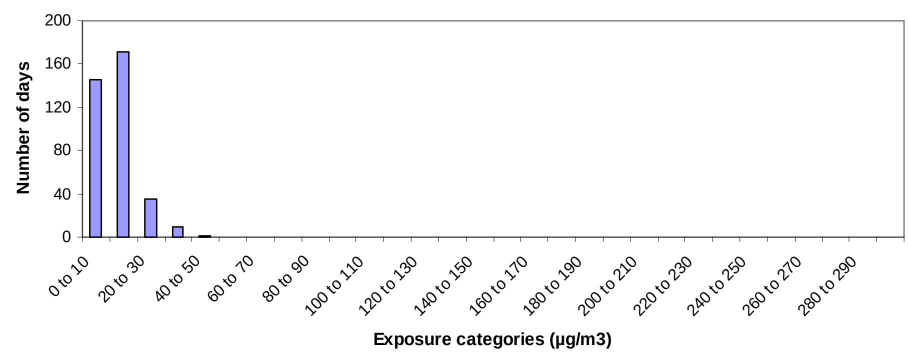
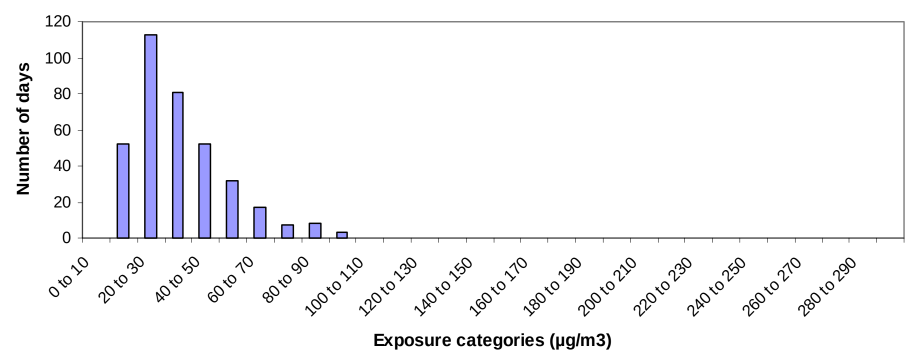
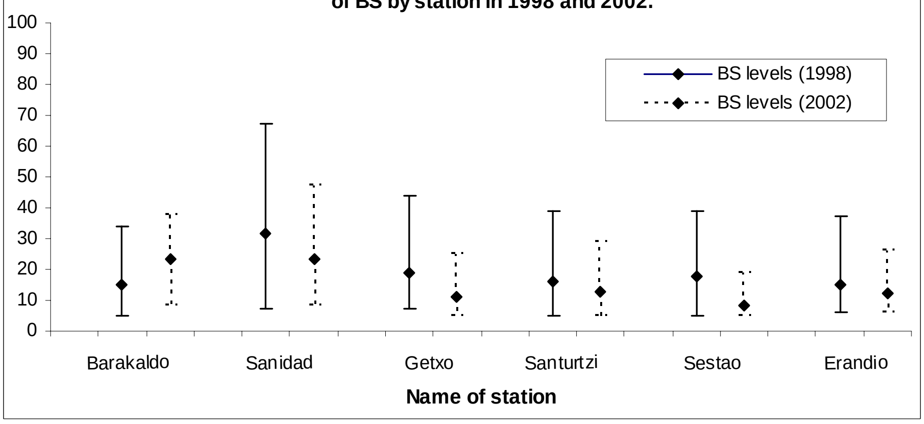


Figure 2: Distribution of PM10 - year



In the Great Bilbao Area BS levels in 2002 are significantly lower than those of 1998 used in APHEIS 2, in all monitoring stations except for the one situated in Barakaldo. In 1998 the mean value of the selected monitoring stations was 18.4 µg/m^3, 29% higher than in 2002. This suggests that there have been changes in traffic emissions, but they have not been assessed.

Figure 3. Annual mean levels and 5th and 95th percentiles of the distribution of BS by station in 1998 and 2002.



The Department of Environment of the Basque Government has recently published the Strategic Plan for the Basque Autonomous Community (2002-2020). In the air quality area the document assumes the compromise of accomplishing the objectives of the European Union. As the objective for PM_{10} in 2010 is 20 µg/m^3 in 2010 the annual mean level should be the 56% of that of the 2002 year.

Health data

We used mortality data of 2001, provided by the Mortality Register of the Basque Autonomous Community that used ICD10. The register has a quality control programme, and its completeness is 100%.

Hospital admissions data of 2001 came from the Hospital Discharge Register of the Basque Autonomous Community and they were coded using ICD9. A Quality control programme is run; the completeness of the Register is 99.9% and the percentage of missing data in cause admission was 0.3%.

Age-standardised mortality rate (per 100000 inhabitants) in 2001 was 684.38.[1]

Table 2. Daily mean number and annual rate per 100000 of deaths and hospital admissions (2001)

Health outcome	ICD9	ICD10	Daily mean number (SD)	Number of cases per 100000/year
Short term HIA				
All causes mortality (excluding external causes)*	< 800	A00-R99	17.0 (4.5)	876.5
Cardiovascular mortality	390-459	I00-I99	5.6 (2.4)	290.1
Respiratory mortality	460-519	J00-J99	1.6 (1.2)	79.8
Cardiac hospital admissions	390-429	I00-I52	10.6 (4.1)	660.9
Respiratory hospital admissions	460-519	J00-J99	12.8 (4.4)	546.3
Long term HIA				
All causes mortality	0-999	A00-Y98	17.6 (4.5)	909.1
Cardiopulmonary mortality	401-440 460-519	I10-I70 J00-J99	6.9 (2.7)	353.8
Lung cancer mortality	162	C33-C34	1.0 (1.1)	52.2

* For short and long term scenarios

Health impact assessment

Different scenarios were used to evaluate short and long-term effects from exposure to particulate pollution, using BS and PM_{10} data. Nevertheless, there are some health effects of suspended particles, such as long term mortality from lung cancer and from cardiopulmonary causes, for which

[1] UNITED NATIONS. Population Division Department of Economic and Social Affairs. World Population Prospects: The 2000 Revision.

risk estimates are only available for the $PM_{2.5}$ fraction. In order to evaluate these effects we converted PM_{10} values into $PM_{2.5}$, multiplying them by the recommended default factor of 0.7.

We used different health indicators (i.e. response variables) depending on the availability of risk estimates (RR) for each pollutant, as shown in Table 3. Short- and long-term impacts on health have been calculated as the number of attributable deaths and hospital admissions per year. In the case of $PM_{2.5}$, long-term impact has been calculated also as the number of expected Years of Life Lost (YoLL) per year. PM_{10} and BS are highly correlated, and $PM_{2.5}$ daily levels have been linearly derived from PM_{10}, so impacts can not be added.

1.- HIA scenarios

1.1.- Short term HIA scenarios for BS

- Reduction of BS levels to a 24-hour value of 50 $\mu g/m^3$ on all days exceeding this value.
- Reduction of BS levels to a 24-hour value of 20 $\mu g/m^3$ on all days exceeding this value.
- Reduction by 5 $\mu g/m^3$ of all the 24-hour values of BS.

1.2.- Short-term HIA of PM_{10} on 0-1 days and cumulative HIA of PM_{10} up to 40 days

- Reduction of PM_{10} levels to a 24-hour value of 50 $\mu g/m^3$ on all days exceeding this value (2005 and 2010 limit values for PM_{10}).
- Reduction of PM_{10} levels to a 24-hour value of 20 $\mu g/m^3$ on all days exceeding this value.
- Reduction by 5 $\mu g/m^3$ of all the 24-hour values.

1.3.- Long-term HIA scenarios for PM_{10}

- Reduction of the annual mean value of PM_{10} to a level of 40 $\mu g/m^3$ (2005 limit values for PM_{10}).
- Reduction of the annual mean value of PM_{10} to a level of 20 $\mu g/m^3$ (2010 limit values for PM_{10}).
- Reduction by 5 $\mu g/m^3$ in the annual mean value of PM_{10}.

1.4.- Long term HIA for $PM_{2.5}$

- Reduction of the annual mean value of $PM_{2.5}$ to a level of 20 $\mu g/m^3$.
- Reduction of the annual mean value of $PM_{2.5}$ to a level of 15 $\mu g/m^3$.
- Reduction by 3.5 $\mu g/m^3$ in the annual mean value of $PM_{2.5}$.

Table 3. Summary SHORT - TERM Health impact assessment (HIA)

	Health indicator	ICD9	ICD10	Tool	RR(95% IC). For 10 $\mu g/m^3$ increase
Attributable cases		**ICD9**	**ICD10**		
PM_{10}	All ages, all causes mortality (excluding external causes)	< 800	A00-R99		WHO, 2003: 1.006 (1.004 - 1.008)
	All ages, cardiovascular mortality	390-459	I00-I99		WHO, 2003: 1.009 (1.005 - 1.013)
	All ages, respiratory mortality	460-519	J00-J99		WHO, 2003: 1.013 (1.005 - 1.021)
	All ages, cardiac hospital admissions	390-429	I00-I52	French PSAS-9	Le Tertre et al., 2002: 1.006 (1.003 - 1.009)
	All ages, respiratory hospital admissions	460-519	J00-J99	Excel spreadsheet	Apheis 3: 1.0114 (1.0062 - 1.0167)
BS	All ages, all causes mortality (excluding external causes)	< 800	A00-R99		WHO, 2003: 1.006 (1.004 - 1.009)
	All ages, cardiovascular mortality	390-459	I00-I99		WHO, 2003: 1.004 (1.002 - 1.007)
	All ages, respiratory mortality	460-519	J00-J99		WHO, 2003: 1.006 (0.998 - 1.015)
	All ages, cardiac hospital admissions	390-429	I00-I52	French PSAS-9	Le Tertre et al., 2002: 1.011 (1.004 - 1.019)
	All ages, respiratory hospital admissions	460-519	J00-J99	Excel spreadsheet	Apheis 3: 1.0030 (0.9985 - 1.0075)
PM_{10} Distributed lag (40 days)	All ages, all causes mortality (excluding external causes)	< 800	A00-R99		Zanobetti et al., 2002: 1.01227 (1.0081 - 1.0164)
	All ages, cardiovascular mortality	390-459	I00-I99	French PSAS-9	Zanobetti et al., 2003: 1.01969 (1.0139 - 1.0255)
	All ages, respiratory mortality	460-519	J00-J99	Excel spreadsheet	Zanobetti et al., 2003: 1.04206 (1.0109 - 1.0742)

Summary LONG - TERM Health impact assessment (HIA)

	Health indicator	ICD9	ICD10	Tool	RR(95% IC). For 10 $\mu g/m^3$ increase	Scenarios
Attributable cases						**Annual mean**
PM_{10}	All causes mortality (excluding external causes)	< 800	A00-R99	French PSAS-9. Excel spreadsheet	Kunzli et al., 2000: 1.043 (1.026 - 1.061)	Reduction to 40 $\mu g/m^3$ Reduction to 20 $\mu g/m^3$ Reduction by 5 $\mu g/m^3$
$PM_{2.5}$	All causes mortality Cardiopulmonary mortality LCA	0-999 401-440 and 460-519 162	A00-Y98 I10-I70 and J00-J99 C33-C34	French PSAS-9. Excel spreadsheet	CA III Pope, 2002: 1.06 (1.02 - 1.11) 1.09 (1.03 - 1.16) 1.14 (1.04 - 1.23)	Reduction to 20 $\mu g/m^3$ Reduction to 15 $\mu g/m^3$ Reduction by 3.5 $\mu g/m^3$
YoLL						**Annual mean**
$PM_{2.5}$	All causes mortality Cardiopulmonary mortality LCA	0-999 401-440 and 460-519 162	A00-Y98 I10-I70 and J00-J99 C33-C34	WHO AirQ software	CA III Pope, 2002: 1.06 (1.02 - 1.11) 1.09 (1.03 - 1.16) 1.14 (1.04 - 1.23)	Reduction to 20 $\mu g/m^3$ Reduction to 15 $\mu g/m^3$ Reduction by 3.5 $\mu g/m^3$

2. Findings

2.1.- BS findings

Graphs 4-5 show the short term impact of BS on mortality and on the number of hospital admissions. The annual number of deaths brought forward by daily BS levels higher than 20 µg/m^3 was 3 (CI: 2-4) and the number of attributable cardiac hospital admissions 3 (CI: 1-6).

Figure 4. Black smoke : reductions to 50-20-by 5 µg/m^3. Short-term health impact on total and specific mortality

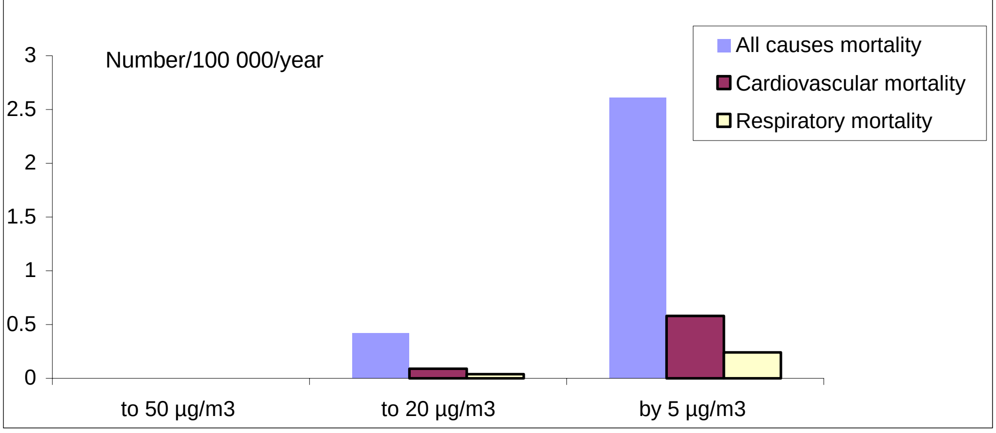
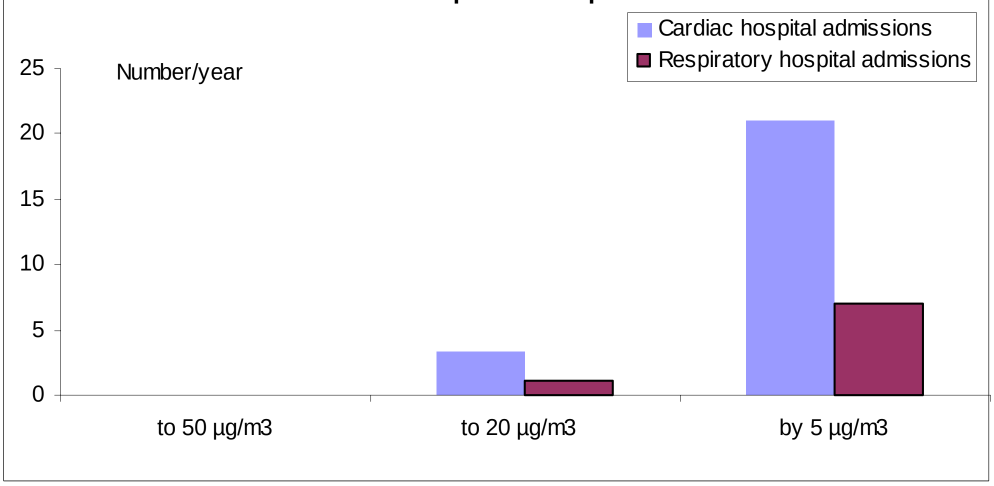


Figure 5. Black smoke : reductions to 50-20-by 5 µg/m3. Short-term health impact on hospital admissions



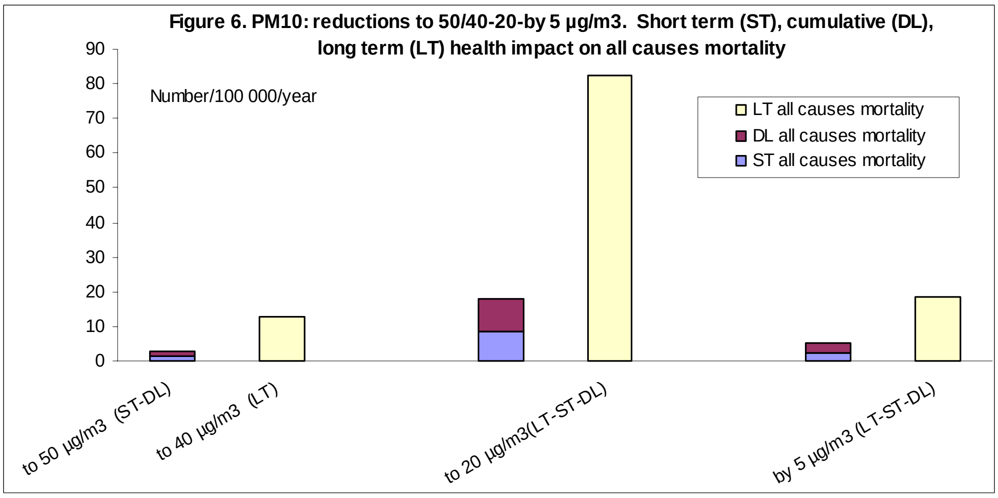
2.2.- PM_{10} findings

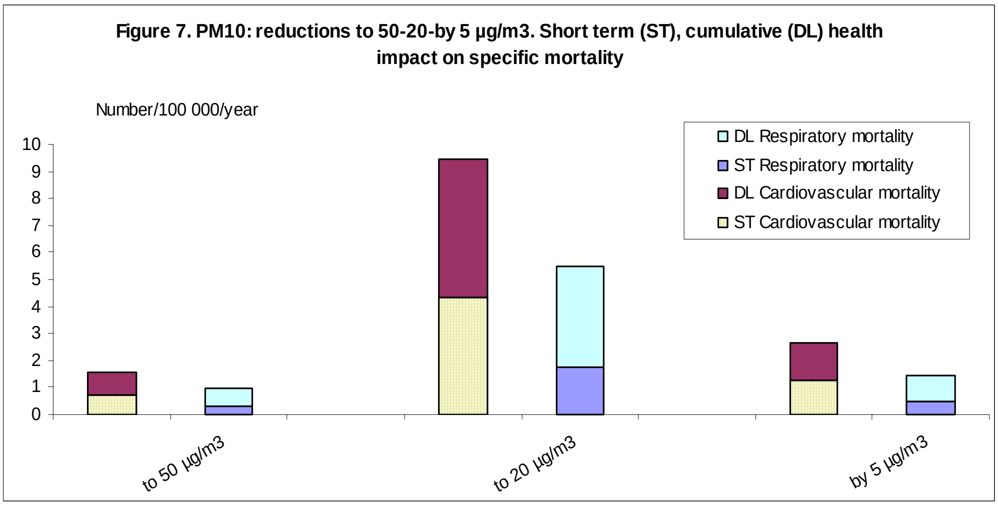
Graphs 6-8 show the health impact of PM_{10} on mortality for different lags: short-term-ST (0-1 day lag), cumulative effect –DL-distributed lag (up to 40 days lag) and long-term LT (years).

The annual number of deaths brought forward, within the 24 hours following the exposure, by daily PM_{10} levels higher than 20 µg/m^3 was 62 (CI: 41-83), 31 (CI: 17-45) from cardiovascular causes and 12 (CI: 5-20) from respiratory diseases.

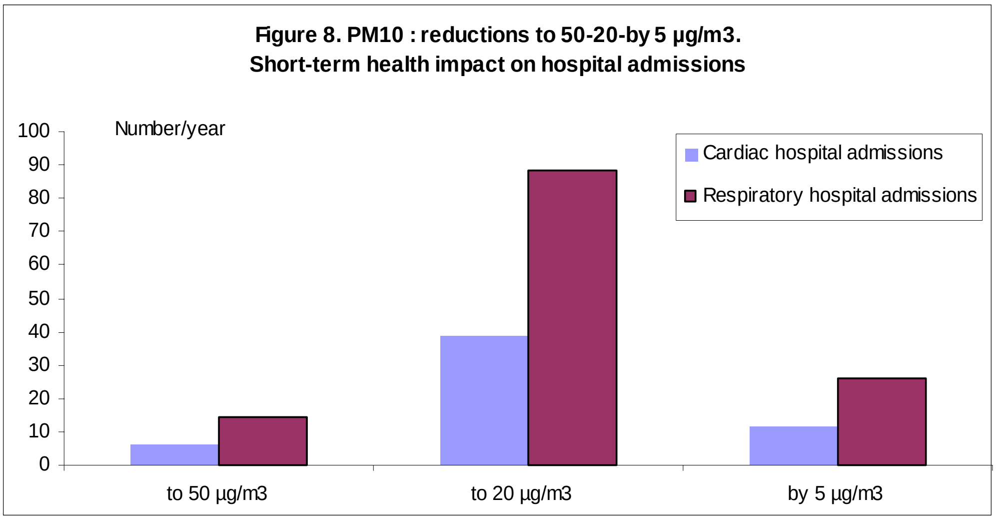
The annual number of deaths brought forward, within the 40 days following the exposure, by daily PM_{10} levels higher than 20 µg/m^3 was 126 (CI: 83-170), 67 (CI: 45-87) from cardiovascular causes and 39 (CI: 10-71) from respiratory diseases.

Including short- and long-term effects, the total annual number of deaths brought forward by annual mean level of PM_{10} above 20 µg/m^3 was 584 (CI: 349-838).





Acute effects of short-term exposure to PM_{10} on cardiac and respiratory hospital admissions over one year are shown in graph 8. The annual number of urgent cardiac admissions within the 24 hours following the exposure to daily PM_{10} levels higher than 20 µg/m^3 was 39 (CI: 19-58) and those from respiratory diseases 89 (CI: 48-131).



2.3.- $PM_{2.5}$ findings

Graph 9 shows the long-term health impact of $PM_{2.5}$ on mortality. The total annual number of deaths brought forward by annual mean level of $PM_{2.5}$ above 15 µg/m^3 was 570 (CI: 144-1026), 322 (CI: 112-553) from cardiopulmonary diseases and 65 (CI: 21-116) from lung cancer.

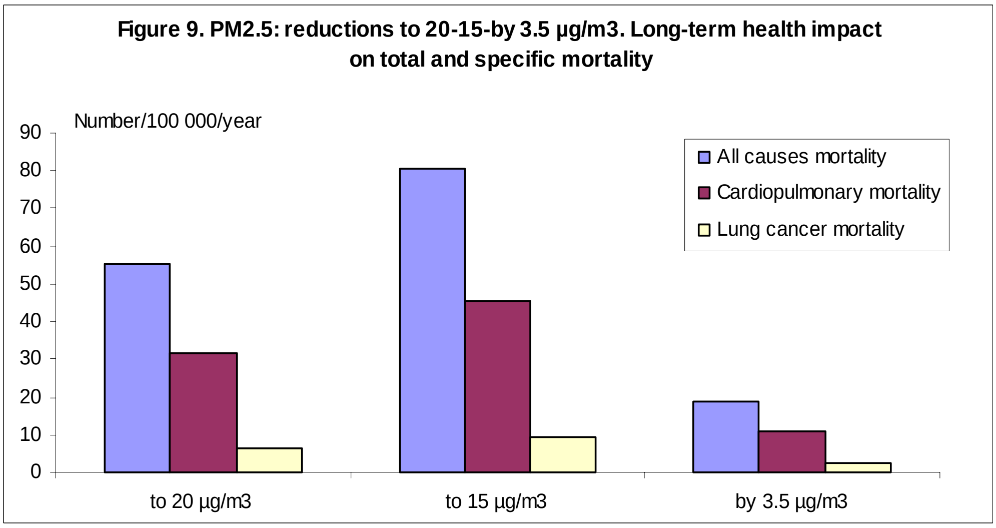


Figure 10 shows the number of YoLL due to attributable deaths, from all causes, cardiopulmonary diseases and lung cancer, within the population older than 30 years. The total number of YoLL attributable to annual $PM_{2.5}$ levels above 15 µg/m^3 are 2700, 1201 from cardiovascular diseases, and 436 from lung cancer.

Figure 10. PM2.5: reductions to 20-15-by 3.5 µg/m3. Expected years of life lost due to the deaths in 2000 for total and specific mortality for >30 years old

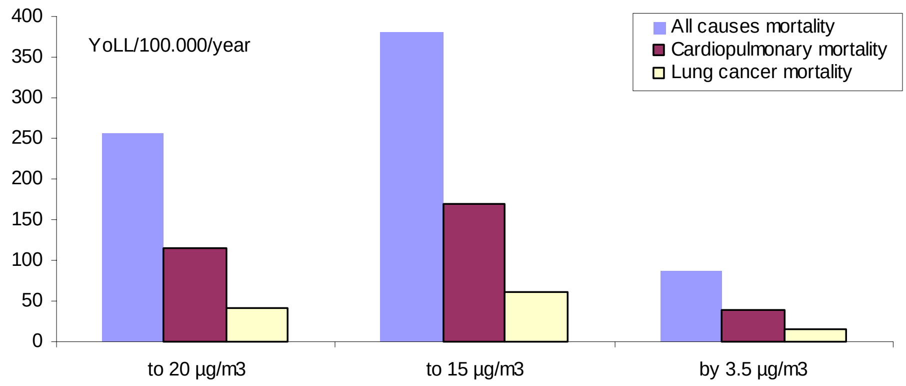


Table 4 presents the findings in terms of life expectancy. If $PM_{2.5}$ annual mean level (30.41 µg/m^3) were lowered to 15 µg/m^3 – what is approximately equivalent to fulfilling the PM_{10} limit of 20 µg/m^3, established for 2010- the life expectancy of a 30 year old person (51 years) would be increased in 0.91 years.

Table 4. Life expectancy and expected increase for a reduction of PM2.5 annual averaged level to 15 µg/m3 in Bilbao area.

		Expected gain in life expectancy		
Age	Life expectancy	Mean	Low estimate	High estimate
At birth	80.15	0.90	0.24	1.56
30	50.99	0.91	0.24	1.58
65	19.48	0.69	0.18	1.21

Interpretation of findings

The number of deaths from all causes attributable to the short term effects of daily PM_{10} levels above 20 µg/m^3 is 62, which represents a rate of 8.7 per 100000. Effects on cardiovascular mortality seem to be bigger than on respiratory mortality. 50% of the total mortality attributable to particulate levels are cardiovascular deaths while about 20% are due to respiratory causes. On the contrary, the number of emergency respiratory admissions attributable to AP is 89, larger than the number of admissions for cardiac diseases (39 cases). Cumulative effects are not negligible. The mortalities from all causes and from cardiovascular diseases attributable to air pollution within a period of 40 days after exposure are twice as big as those within the following 24 hours and, in the case of respiratory mortality, it is three times bigger.

Long term effects are still larger. In the Greater Bilbao, the total number of deaths per year (excluding external causes) that would be delayed by a reduction of annual PM_{10} mean to 20 µg/m^3 is 584 (CI: 349-838), what means an annual rate of 82 deaths/100000. The central estimate of the number of attributable deaths for the same scenario, using the RR of $PM_{2.5}$ for all causes and the converted $PM_{2.5}$ values, is quite the same (570) but the confidence interval much larger (144-1027).

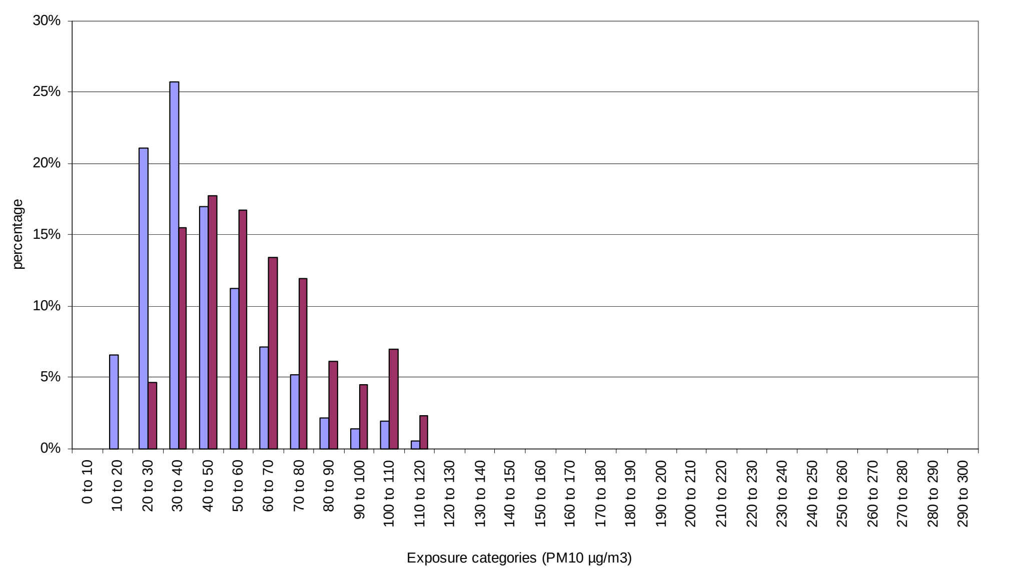
According to our results 56% of the attributable deaths would be caused by cardiopulmonary diseases and 15% by lung cancer.

Further information about the impact of air pollution on health is given by the number of YoLL (YoLL) or the reduction in life expectancy that attributable deaths imply. This depends on the number of deaths attributable and on the extent in which the attributable deaths are brought forward. According to our calculations, the 570 deaths from all causes, attributable in Bilbao to $PM_{2.5}$ annual mean levels above 15 $\mu g/m^3$ would represent 2700 YoLL. In other words, lowering the annual $PM_{2.5}$ levels to 15 $\mu g/m^3$ – what is approximately equivalent to fulfilling the PM_{10} limit of 20 $\mu g/m^3$, established for 2010- would save 2700 years of life, and life expectancy at the age of 30 years would be increased in 0.91 year.

In the same way a reduction of $PM_{2.5}$ of 3.5 $\mu g/m^3$ would imply saving about 620 years of life per year, 279 from cardiopulmonary diseases and 104 from lung cancer, what would represent an increase in life expectancy at the age of 30 of 0.21 year.

One interesting point related to the results of health impact assessment is the levels at which deaths or emergency hospital admissions are occurring. For calculations, we have assumed that dose-response relationship is linear at every air pollution level. Under this hypothesis the number of respiratory hospital admissions attributable to peak levels, such as days with an averaged PM_{10} level above 80-90 $\mu g/m^3$ is about 10% of the total attributable admissions.

Figure11: Distribution of daily PM10 levels and associated respiratory admissions (%)



Conclusions

Health impact of existing suspended particles levels is measurable and not negligible. Health impact assessment can be an important input at setting environmental policies. Further research is still needed to assess and compare the impacts of different environmental risks.

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Appendix

Exposure measurement methods

Harmonised compilation of information indicating the exposure relevant area of the city, number of PM_{10}, $PM_{2.5}$ or BS monitoring sites, and the type, sampling and measurement characteristics of stations selected for the HIA of APHEIS.

City .... Bilbao

Total area of agglomeration (km²)........ 116.9 km²

Area (km²) covered by the air monitoring network in the city .... 116.9 km²

Number of population in this (exposure relevant) area........ 708395

Total number of PM_{10} monitoring stations in this area........ 5

Number of selected PM_{10} monitoring stations for HIA 4

Total number of BS monitoring stations in this area........ 6

Number of selected BS monitoring stations for HIA........ 6

Measurement interval.

BS........ 24 hours

PM_{10}........ continuous

Quality assurance and control .... no

Data quality .... validated data

Name, classification and sampling characteristics of the monitoring site (traffic, kerbside, building line, commercial, urban residential, sub-urban, rural, industrial, others).

Name	PM_{10}/BS/$PM_{2.5}$	Classification
Barakaldo-San Eloy	BS	Urban residential
Bilbao-Sanidad	BS	Urban residential
Erandio-Arriaga	BS	Urban residential
Getxo-Las Arenas	BS	Urban residential
Santurtzi-Ayuntamiento	BS	Urban residential
Sestao-Plaza	BS	Urban residential
Barakaldo	PM_{10}	Urban residential
Bilbao-Mazarredo	PM_{10}	Urban residential
Portugalete-Naútica	PM_{10}	Sub-urban
Getxo-Algorta	PM_{10}	Urban residential

Measurement method / Type of instrument.

BS........ Reflectometry (EEL reflectometer and Whatman No. 1 filter paper)

PM_{10} .... automated (β radiation absorption. probe temperature 45 °C)

Using PM_{10} data for your city HIA calculation, did you used a conversion factor in order to compensate losses of volatile particulate matter?... Yes

a) Which factor:.. 1.20

b) Is it a default factor? ....No

c) Derived from own parallel measurements? .... Yes

If your $PM_{2.5}$ data have been calculated from your PM_{10} data, what conversion factor did you use?

Factor .... 0.7 (default value)

Health data

Mortality data

Type of source ....Register

Source .... Mortality Register of the Basque Autonomous Community

Year 2001

Quality control program ....yes

Percentage of cases registered with missing data in the basic cause of death.....................0%

Codification ....Manual (100%)

ICD10...yes

Hospital admission data

Source .... Hospital Discharge Register. Basque Autonomous Community

Year 2001

Definition of episodes included..urgent admissions

Codification.

Hospital admission for cardiac diseases (all ages) (ICD9: 390-429) 2001

Hospital admission for respiratory diseases (all ages) (ICD9: 460-519) 2001

Quality control program ....yes

Completeness of the register: The Public Health Service accounts for more than 98% of the total urgent admissions in the area.

Hospitals of the Public Health Service 100%

Private hospitals .... about 95%

Percentage of cases registered with missing data in the cause of admission 0.3% (year 2001)

Type of Hospital admissions considered in the analysis........................ emergency admissions

Tables for BS findings

Tables 1, 2 and 3 present the attributable number of all causes, cardiovascular and respiratory deaths expressed as absolute numbers and as rates per 100000 inhabitants. Table 4 presents the results for cardiac and respiratory hospital admissions.

Table 1. Deaths all causes (ICD10 A00 R99) (2001). Potential benefits of reducing daily BS levels (2002) above 20 to 20 µg/m³, above 50 to 50 µg/m³ and all days by 5 µg/m³. Absolute number and number per 100000 inhabitants (95% confidence limits) attributable to the acute effects of BS

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m³	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100000 central	N° of deaths per 100000 lower	N° of deaths per 100000 upper
20 µg/m³	47	2.96	1.98	4.45	0.42	0.28	0.63
50 µg/m³	0	0.00	0.00	0.00	0	0	0
By 5 µg/m³	NA*	18.51	12.35	27.74	2.61	1.74	3.92

*NA: not applicable

Table 2. Cardiovascular deaths (ICD10 I00 I99) (2001). Potential benefits of reducing daily BS levels (2002) above 20 to 20 µg/m³, above 50 to 50 µg/m³ and all days by 5 µg/m³. Absolute number and number per 100000 inhabitants (95% confidence limits) attributable to the acute effect of BS

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m³	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100000 central	N° of deaths per 100000 lower	N° of deaths per 100000 upper
20 µg/m³	47	0.65	0.33	1.14	0.09	0.05	0.16
50 µg/m³	0	0.00	0.00	0.00	0.00	0.00	0.00
By 5 µg/m³	NA*	4.09	2.05	7.16	0.58	0.29	1.01

*NA: not applicable

Table 3. Respiratory deaths (ICD10 J00 J99) (2001). Potential benefits of reducing daily BS levels (2002) above 20 to 20 µg/m³, above 50 to 50 µg/m³ and all days by 5 µg/m³. Absolute number and number per 100000 inhabitants (95% confidence limits) attributable to the acute effects of BS

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m³	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100000 central	N° of deaths per 100000 lower	N° of deaths per 100000 upper
20 µg/m³	47	0.27	-0.09	0.68	0.04	-0.01	0.10
50 µg/m³	0	0.00	0.00	0.00	0.00	0.00	0.00
By 5 µg/m³	NA*	1.69	-0.56	4.21	0.24	-0.08	0.59

*NA: not applicable

Table 4. Cardiac (ICD9 390-429) and respiratory (ICD9 460-519) hospital admissions(2001). Potential benefits of reducing daily BS levels (2002) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number (95% confidence limits) attributable to the acute effects of BS

		Attributable cases per year		
Scenarios	Number of days per year exceeding 20 and 50 µg/m^3	N° of deaths central	N° of deaths lower	N° of deaths upper
Hospital admissions for cardiac diseases (all ages)				
20 µg/m^3	47	3.40	1.24	5.88
50 µg/m^3	0	0.00	0.00	0.00
By 5 µg/m^3	NA*	21.03	7.66	36.26
Hospital admissions for respiratory diseases (all ages)				
20 µg/m^3	47	1.12	-0.56	2.79
50 µg/m^3	0	0.00	0.00	0.00
By 5 µg/m^3	NA*	7.00	-3.51	17.49

*NA: not applicable

Tables for PM_{10} findings

1.- Health effects of PM_{10} on 0-1 days

Tables 5, 6 and 7 present the attributable number of all causes. Cardiovascular and respiratory deaths expressed as absolute numbers and as rates per 100000 inhabitants. Table 8 presents the results for cardiac and respiratory hospital admissions.

Table 5. Deaths all causes (ICD10 A00 R99) (2001). Potential benefits of reducing daily PM_{10} levels (2002) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number and number per 100000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m^3	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100000 central	N° of deaths per 100000 lower	N° of deaths per 100000 upper
20 µg/m^3	313	61.95	41.21	82.79	8.75	5.82	11.69
50 µg/m^3	67	10.10	6.72	13.48	1.43	0.95	1.90
By 5 µg/m^3	NA*	18.25	12.18	24.33	2.58	1.72	3.43

*NA: not applicable

Table 6. Cardiovascular deaths (ICD10 I00 I99) (2001). Potential benefits of reducing daily PM_{10} levels (2002) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number and number per 100000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m^3	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100000 central	N° of deaths per 100000 lower	N° of deaths per 100000 upper
20 µg/m^3	313	30.71	16.99	44.57	4.34	2.40	6.29
50 µg/m^3	67	5.04	2.79	7.31	0.71	0.39	1.03
By 5 µg/m^3	NA*	8.97	4.99	12.95	1.27	0.70	1.83

*NA: not applicable

Table 7. Respiratory deaths (ICD10 J00 J99) (2001). Potential benefits of reducing daily PM_{10} levels (2002) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number and number per 100000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m^3	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100000 central	N° of deaths per 100000 lower	N° of deaths per 100000 upper
20 µg/m^3	313	12.19	4.65	19.88	1.72	0.66	2.81
50 µg/m^3	67	2.02	0.77	3.29	0.29	0.11	0.46
By 5 µg/m^3	NA*	3.52	1.36	5.68	0.50	0.19	0.80

*NA: not applicable

Table 8. Cardiac (ICD9 390-429) and respiratory (ICD9 460-519) hospital admissions (2001). Potential benefits of reducing daily PM_{10} levels (2002) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year		
Scenarios	Number of days per year exceeding 20 and 50 µg/m^3	N° of deaths central	N° of deaths lower	N° of deaths upper
Hospital admissions for cardiac diseases (all ages)				
20 µg/m^3	313	38.61	19.24	58.11
50 µg/m^3	67	6.29	3.14	9.46
By 5 µg/m^3	NA*	11.38	5.69	17.05
Hospital admissions for respiratory diseases (all ages)				
20 µg/m^3	313	88.56	47.88	130.53
50 µg/m^3	67	14.64	7.93	21.53
By 5 µg/m^3	NA*	25.69	13.99	37.59

*NA: not applicable

2.- Cumulative health effects of PM_{10} up to 40 days

Tables 9, 10 and 11 present the attributable number of all causes. Cardiovascular and respiratory deaths expressed as absolute numbers and as rates per 100000 inhabitants.

Table 9. Cumulative health effects of PM_{10} up to 40 days and all causes of deaths (ICD 10 A00-R99) (2001). Potential benefits of reducing daily PM_{10} levels (2002) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number and number per 100000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m^3	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100000 central	N° of deaths per 100000 lower	N° of deaths per 100000 upper
20 µg/m^3	313	126.33	83.00	169.65	17.83	11.72	23.95
50 µg/m^3	67	20.92	13.77	28.06	2.95	1.94	3.96
By 5 µg/m^3	NA*	36.56	24.16	48.81	5.04	3.33	6.73

*NA: not applicable

Table 10. Cumulative health effects of PM_{10} up to 40 days and cardiovascular deaths (ICD10 I00-I99) (2001). Potential benefits of reducing daily PM_{10} levels (2002) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number and number per 100000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m^3	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100000 central	N° of deaths per 100000 lower	N° of deaths per 100000 upper
20 µg/m^3	313	66.87	46.90	87.19	9.44	6.62	12.31
50 µg/m^3	67	11.29	7.94	14.69	1.59	1.12	2.07
By 5 µg/m^3	NA*	18.94	13.39	24.50	2.67	1.89	3.46

*NA: not applicable

Table 11. Cumulative health effects of PM_{10} up to 40 days and respiratory deaths (ICD10 J00 J99) (2001). Potential benefits of reducing daily PM_{10} levels (2002) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number and number per 100000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m^3	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100000 central	N° of deaths per 100000 lower	N° of deaths per 100000 upper
20 µg/m^3	313	38.97	9.74	71.42	5.50	1.38	10.08
50 µg/m^3	67	6.96	1.76	12.60	0.98	0.25	1.78
By 5 µg/m^3	NA*	10.35	2.70	18.13	1.46	0.38	2.56

*NA: not applicable

3.- Long term HIA for PM_{10}

Table 12 presents the attributable number of all causes of deaths expressed as absolute numbers and as rates per 100000 inhabitants.

Table 12. Deaths all causes (ICD10 A00 R99) (2001). Potential benefits of reducing annual mean values of PM_{10} (2002) to levels of 20 and 40 µg/m³, and by 5 µg/m³. Absolute number of deaths and number of deaths per 100000 inhabitants (95% confidence limits) attributable to the chronic effects of PM_{10}

	Attributable cases per year					
	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100000 central	N° of deaths per 100000 lower	N° of deaths per 100000 upper
20 µg/m³	583.50	348.86	837.60	82.37	49.25	118.24
40 µg/m³	89.33	54.31	126.01	12.61	7.67	17.79
By 5 µg/m³	129.33	78.52	182.67	18.26	11.08	25.79

Tables for $PM_{2.5}$ findings

1.- LT $PM_{2.5}$: Attributable Cases

Tables 13, 14 and 15 present the attributable number of all causes. Cardiopulmonary and lung cancer deaths expressed as absolute numbers and as rates per 100000 inhabitants. .

Table 13. Deaths all causes (ICD10 A00 R99) (2001). Potential benefits of reducing annual mean values of $PM_{2.5}$ to levels of 15 and 20 µg/m³, and by 3.5 µg/m³. Absolute number of deaths and number of deaths per 100000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2.5}$

	Attributable cases per year					
	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100000 central	N° of deaths per 100000 lower	N° of deaths per 100000 upper
15 µg/m³	570.00	144.40	1026.75	80.46	20.38	144.94
20 µg/m³	390.81	100.13	695.91	55.17	14.13	98.24
By 3.5 µg/m³	134.14	34.90	235.15	18.94	4.93	33.20

Table 14. Cardiopulmonary deaths (ICD10 I10-I70 and J00-J99) (2001). Potential benefits of reducing annual mean values of $PM_{2.5}$ to levels of 15 and 20 µg/m³, and by 3.5 µg/m³. Absolute number of deaths and number of deaths per 100000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2.5}$

	Attributable cases per year					
	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100000 central	N° of deaths per 100000 lower	N° of deaths per 100000 upper
15 µg/m³	322.34	111.77	552.79	45.50	15.78	78.03
20 µg/m³	222.57	78.31	376.01	31.42	11.05	53.08
By 3.5 µg/m³	77.15	27.69	127.73	10.89	3.91	18.03

Table 15. Lung cancer deaths (ICD9 162) (2001). Potential benefits of reducing annual mean values of $PM_{2.5}$ to levels of 15 and 20 µg/m^3, and by 3.5 µg/m^3. Absolute number of deaths and number of deaths per 100000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2.5}$

	Attributable cases per year					
	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100000 central	N° of deaths per 100000 lower	N° of deaths per 100000 upper
15 µg/m^3	65.39	20.90	116.04	9.23	2.95	16.38
20 µg/m^3	45.56	14.88	79.05	6.43	2.10	11.16
By 3.5 µg/m^3	15.99	5.38	26.93	2.26	0.76	3.80

2.- LT $PM_{2.5}$: YoLL

Tables 16, 17 and 18 present the YoLL of all causes. Cardiopulmonary and lung cancer deaths expressed as absolute numbers and as rates per 100000 inhabitants.

Table 16. Deaths all causes >30 years, male and female, for one year (ICD9 0-999) (2001). Potential benefits of reducing annual mean values of $PM_{2.5}$ to levels of 15 and 20 µg/m^3, and by 3.5 µg/m^3. YoLL (YoLL) and YoLL per 100000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2.5}$

	YoLL					
	YoLL central	YoLL lower	YoLL upper	YoLL per 100000 central	YoLL per 100000 lower	YoLL per 100000 upper
15 µg/m^3	2701.53	715.99	4647.95	379.63	100.61	653.16
20 µg/m^3	1832.90	484.22	3163.62	257.57	68.05	444.57
By 3.5 µg/m^3	619.98	163.07	1074.85	87.12	22.91	151.04

Table 17. Cardiopulmonary deaths >30 years, male and female, for one year (ICD9 401-440 and 460-519) (2001). Potential benefits of reducing annual mean values of $PM_{2.5}$ to levels of 15 and 20 µg/m^3, and by 3.5 µg/m^3. YoLL (YoLL) and YoLL per 100000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2.5}$

	YoLL					
	YoLL central	YoLL lower	YoLL upper	YoLL per 100000 central	YoLL per 100000 lower	YoLL per 100000 upper
15 µg/m^3	1200.79	446.27	1916.14	168.74	62.71	269.27
20 µg/m^3	819.17	301.89	1318.38	115.11	42.42	185.27
By 3.5 µg/m^3	279.07	101.66	454.40	39.22	14.29	63.85

Table 18. Lung cancer deaths >30 years, male and female, for one year (ICD9 162) (2001). Potential benefits of reducing annual mean values of $PM_{2.5}$ to levels of 15 and 20 µg/m³, and by 3.5 µg/m³. YoLL (YoLL) and YoLL per 100000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2.5}$

	YoLL					
	YoLL central	YoLL lower	YoLL upper	YoLL per 100000 central	YoLL per 100000 lower	YoLL per 100000 upper
15 µg/m³	436.41	158.27	681.80	61.33	22.24	95.81
20 µg/m³	300.37	106.82	478.24	42.21	15.01	67.20
By 3.5 µg/m³	103.65	35.86	169.55	14.57	5.04	23.83