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HEALTH IMPACT ASSESSMENT OF AIR POLLUTION

ENHIS-1 PROJECT: WP5 HEALTH IMPACT ASSESSMENT

LOCAL CITY REPORT

BILBAO

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Bilbao, August 2005

Summary of main findings for Bilbao

In 2002 the PM_{10} annual mean (SD) was 36.2 (16.9) µg/m^3, above the 1999/30/EC Directive limit for 2010 (20 µg/m3), and below that established for 2005 (40 µg/m^3). For the summer period of the same year the P5 (5th percentile), P50 and P95 of the maximum daily 8-hour moving average concentration of ozone were 34, 59, and 82 µg/m^3.

The reduction of annual average levels of particles to 20 µg/m^3 would prevent 0.52 postneonatal deaths from occurring. As far as short term effects of O_3 in summer are concerned, each reduction of 10 µg/m^3 in maximum daily 8-hour moving average concentrations would delay 9 deaths/year in the study area, 4 from cardiovascular diseases, and 4 from respiratory causes.

Postneonatal mortality does not seem to be a sensitive indicator to assess the impact of AP (air pollution) by suspended particles on children health. Ozone levels are not high in Bilbao urban area and so are the attributable number of deaths

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Summary of HIA of outdoor air pollution in Bilbao in ENHIS-1								
Health outcome	**Population**	**Pollutant**	**Period**	**Mean type**	**RR (for 10 µg/m³ increase)**	**References**	**Number of attributable cases by scenario**[1]	
Mortality							**Ozone: Reduction by 10 µg/m³**	**PM_{10}**[3]**: Reduction by 5 µg/m³**
Total mortality excluding external causes (ICD9 < 800 - ICD10 A00-R99)	All ages	O_3 8h max	Summer[2]	Daily	1.0031 (1.0017-1.0052)	Gryparis et al 2004	8.99 (4.93- 15.08)	
Cardiovascular mortality (ICD9 390 -459 - ICD10 I00-I99)					1.0046 (1.0022-0.0073)		4.29 (2.05- 6.81)	
Respiratory mortality (ICD9 460-519 - ICD10 J00-J99)					1.0113 (1.0074-1.0151)		3.55 (2.32- 4.74)	
Total postneonatal mortality	1 month- 1 year	Corrected PM_{10}[3]	Year	Annual	1.048 (1.022-1.075)	Lacasaña et al 2005		0,12 (0,05-0,18)
Postneonatal respiratory mortality (ICD9 460-519 - ICD10 J00 -J99)					1.216 (1.102-1.342)			0
Postneonatal Sudden Infant Death Syndrome Mortality (ICD9 798.0 - ICD10 R95)					1.12 (1.07-1.17)	Woodruff 1997		0
Morbidity								
Emergency room visits for asthma (ICD -9 codes 493, ICD-10 codes J45, J46)	< 18 years	O_3 1h max	Year	Daily	1.0115 (1.0067-1.0163)	CARB 2004	not available	
Cough	< 18 years	Measured PM_{10}			1.0407 (1.0202-1.0511)	Ward and Ayres 2004		not available
Lower respiratory symptoms LRS	< 18 years	Measured PM_{10}			1.0407 (1.0202 -1.617)	Ward and Ayres 2004		not available
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00 -J99)	< 15 years	Measured PM_{10}			1.010 (0.998-1.021)	Anderson et al 2004		3.14 ((-0.63)-6.57)
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00 -J99)	15 - 64 years	O_3 8h max	Summer		1.001 (0.991-1.012)		0.69 ((-6.22)-8.29)	
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00 -J99)	> 64 years				1.005 (0.998-1.012)		8.20 ((-3.28)-19.69)	

[1] For ozone: absolute reduction by 10 µg/m³. For PM_{10} absolute reduction by 5 µg/m³.

[2] Definition of summer period : 01 April – 30 September

[3] PM_{10} reference papers for HIA on postneonatal mortality use gravimetric methods to measure PM_{10}. As Bilbao air quality network uses an automatic method (ß-radiation absorption) a correction factor is required to compensate for loss of volatile compounds: Bilbao correction factor has been 1.2

Introduction

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 industrialization, 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 of the lack of relative risk (RR) of BS for long term effects on mortality. The annual number of deaths brought forward by daily BS levels higher than 20 ?g/m^3 was 11.1 with a 95% confidence interval (CI) of 5.5-14.7), the number of attributable cardiac hospital admissions was 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).

The second HIA of AP in Bilbao area was also performed within Apheis project, and it was aimed to evaluate the effects of suspended particles on health, including both short and long term effects. PM_{10} from 2002 were used, for PM2.5 data were lacking in this year. Both short and long term effects of PM_{10} were 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. The impact of long term effects of AP turned out to be an order of magnitude larger. If annual mean of PM_{10} in Bilbao were reduced to 20 µg/m3, 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.

In this report we present a new HIA of air pollution, which includes impact results of ozone levels on general population mortality and hospital respiratory admissions, and impact results of particles levels on postneonatal mortality and children hospital admissions. This work has been carried out within the framework of package 5 of ENHIS-1 project (www.enhis.net).

Sources of air pollution

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

The Department of Environment of the Basque Government 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.

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.

PM_{10} data fulfill Apheis Guidelines on Exposure Assessment. The data are from year 2002, first year in the area in which PM_{10} were monitored in a representative number of 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 ? radiation absorption in all the monitoring stations and the probe temperature 45ºC. A correction factor of 1.2 (value from a local study) has been used to compensate losses of volatile particulate matter. Data presented in this report are those given by the monitoring network, i.e. not corrected, although only corrected values have been used to calculate the attributable fraction of PM_{10} on postneonatal mortality, because the selected RRs were established for particles measured with a gravimetric method.

Five urban monitoring stations have been available for ozone. The analytical method used is UV photometric method (ISO FDIS 13964).

We have calculated the average of hourly values of all selected monitoring stations in the area, and created one series of hourly average data. On this series:

a) The 1 hour maximum concentration of each day has been selected, to create a series of 365 1 hour max daily data

b) The 8 hour moving averages of each day have been calculated for the summer period (1st April to 30th September) and selected the maximum, to create the series of 8 hr daily maximum moving average.

The annual mean level (SD) of PM_{10} in 2002 was 36.2 (16.9) µg/m^3, and P5 and P95 of the daily mean values were, respectively, 16.1 µg/ m^3 and 69.5 µg/m^3. The median, P5 and P95 of the maximum daily 8-hour moving average concentrations of O_3 were, respectively, 59.1, 34.0 y 82.1 µg/ m^3, and those of the maximum daily 1-hour concentrations 59.8, 27.6 and 88.4 µg/m3 (Table 1). Annual distributions of daily values of both PM_{10} and O_3 indicators follow a typical skewed log normal pattern (Figures 1-3)

Table 1. Descriptive statistics of ozone and particle levels. Bilbao area, 2002

	O_3 8h - summer	O_3 1h max - year	PM_{10} - year
Number	183	365	365
Minimum	25.08	11.25	11.88
Percentile 5	34.04	27.56	16.06
Percentile 25	51.05	47.80	24.22
Median	59.13	59.80	31.67
Percentile 75	69.79	70.00	45.49
Percentile 95	82.11	88.43	69.50
Percentile 98	91.11	95.69	83.78
Maximum	103.65	109.60	99.80
Daily mean	59.83	58.72	36.20
standard error	14.41	18.19	16.95
% missing values	0.00%	0.00%	0.00%

Fig 1. Distribution of daily O3 8h max in Bilbao area. Summer 2002

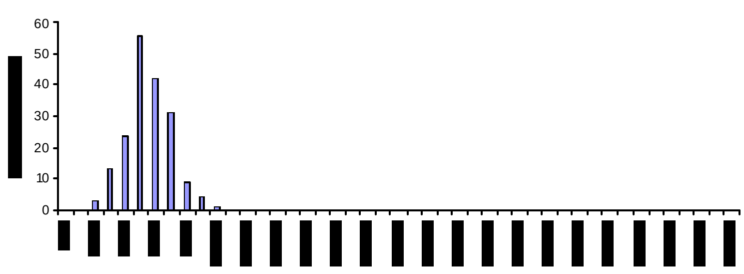


Fig 2. Distribution of daily O3 1 h max in Bilbao area. Summer 2002

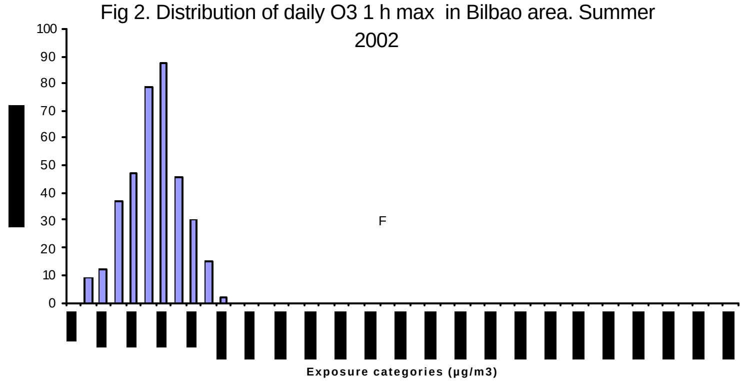
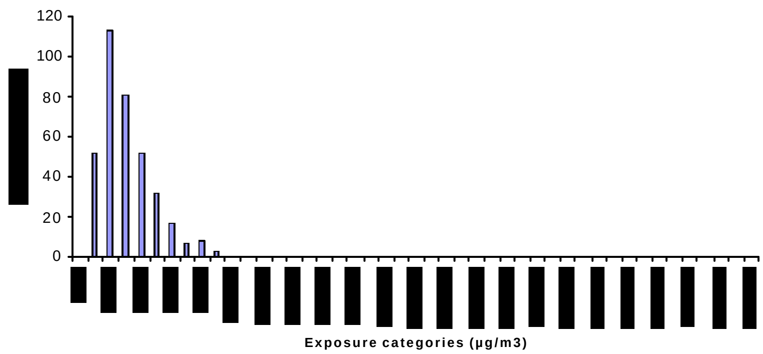
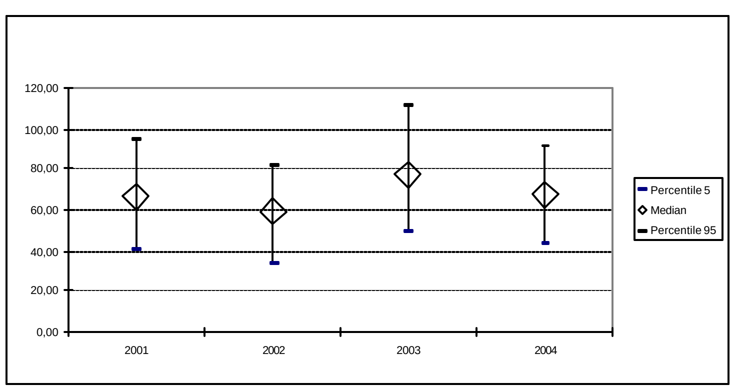


Fig 3. Distribution of daily PM10 daily values in Bilbao area. Yr 2002



Ozone levels in 2002 were lower than usual, in all likelihood due to the fact that 2002 summer was especially cloudy and warm. While the average temperature in August was 20.1ºC in 2001 and 22.3ºC in 2003, it was only 17.5 ºC in 2002. Differences in maximum daily temperature were still larger, August average was 7ºC less in 2002 than in 2003.

Figure 4. P5, P95, and medians of the maximum daily 8-hour moving average concentrations of O_3 in Bilbao area in 2001-2004.



Health data

We used mortality data of 2002, provided by the Mortality Register of the Basque Autonomous Community. The register has a quality control program, uses ICD10, and its completeness is 100%.

The (European population) age-standardized mortality rate of the municipalities of the study area in 2002 was 659.42/100.000. Excluding those due to external causes, the daily average number of deaths in the study area is 15.9, 5.12 of them (32%) being from cardiovascular diseases.Only 5 postneonatal deaths occurred in 2002, which represents 99.1 cases/100.000 1-12 month old children. None of these deaths was caused by SIDS or respiratory diseases.

Hospital admissions data of 2002 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%.

Table 2. Descriptive statistics for health outcomes in Bilbao in 2002. Number of cases and number of cases /100 000

Health outcome	ICD9	ICD10	Nº Cases/year	Daily mean (SD)	Nº cases per 100 000/year
POSTNEONATAL MORTALITY					
Total			5	-	99.10
Respiratory	460-519	J00-J99	0	-	0
Sudden infant death syndrome (SIDS)	798.0	R95	0	-	0
GENERAL POPULATION MORTALITY					
Total mortality all causes	<800	A00-R99	5803	15.90 (4.23)	819.18
Cardiovascular mortality	390-459	I00-I99	1869	5.12 (2.38)	263.84
Respiratory mortality	460-519	J00-J99	633	1.73 (1.44)	89.36
MORBIDITY					
Cough			not available		
Lower respiratory symptoms LRS			not available		
Emergency room visits for asthma - Age < 18 years	493	J45-J46	not available		
Hospital respiratory admissions - Age < 15 years	460-519	J00-J99	632	1.73 (1.90)	803.88
Hospital respiratory admissions - Age 15 -64 years	460-519	J00-J99	1379	3.78 (2.38)	279.60
Hospital respiratory admissions - Age > 64 years	460-519	J00-J99	3289	9.01 (4.38)	2423.12

No data of emergency room visits for asthma, and prevalence of cough and lower respiratory symptoms (LRS) were available in Bilbao for 2002.

Health Impact Assessment

Methodology

Health impact of air pollution (AP) has been calculated as the annual number of health events attributable to AP in the target population. First of all, it is necessary to take into account the fact that the HIA implies assuming a causal relationship between AP and the effects and, therefore, that HIA can only be performed for those outcomes with sufficient evidence of causality. Once the effects with sufficient evidence of causal relationship with AP have been determined, the next step is to find the best exposure-response functions (ERFs) for each of the selected outcomes. Table 3 shows the result of a systematic review on these issues carried out by the Bilbao Apheis team[1] for WP5 of ENHIS-1. This table summarizes the health outcomes and ERFs deemed suitable for HIA according to the criteria established by WP5 with the advice of the air pollution experts of WP5[2].

Table 3. Health outcomes and Exposure-response functions (ERFs) selected for health impact assessment

OUTCOME	POLLUTANT	ERFs	ORIGINAL SOURCE
CHILDREN - PARTICLES			
Total postneonatal mortality (1 month-1 year)	PM_{10} Annual Mean	RR=1.048 (1.022-1.075) ?10µg/m^3	Lacasaña et al 2005
Postneonatal respiratory mortality ICD9 460-519 ICD10 J00-J99	PM_{10} Annual Mean	RR=1.216 (1.102-1.342) ?10µg/m^3	Lacasaña et al 2005
Postneonatal Sudden Infant Death Syndrome (SIDS) mortality (normal birth weight =2500g) ICD9 798.0 –ICD10 R95	PM_{10} Annual Mean	Adjusted Odds Ratio AOR=1.12 (1.07-1.17) ?10µg/m^3	Woodruff et al. 1997
Cough	PM_{10} Daily Mean	OR=1.041 (1.020-1.062) ?10µg/m^3	Ward & Ayres 2004
Lower respiratory symptoms LRS	PM_{10} Daily Mean	OR=1.041 (1.020-1.051) ?10µg/m^3	Ward & Ayres 2004
CHILDREN – OZONE			
Emergency room visits for asthma <18 Y ICD9 493, ICD10 J45 J46	Ozone Maximum 1 h	RR=1.0116 (1.0067-1.0165) ?10µg/m^3	CARB 2004
ADULTS/GENERAL POPULATION			
Total mortality all causes ICD9 <800 ICD10 A00-R99	Ozone Maximum 8 h Summer	RR= 1.0031 (1.0017-1.0052) ?10µg/m^3	Gryparis et al 2004 (APHEA 2)
Respiratory mortality ICD9 460-519 ICD10 J00-J99	Ozone Maximum 8 h Summer	RR= 1.0113 (1.0074-1.0151) ?10µg/m^3	Gryparis et al 2004 (APHEA 2)
Cardiovascular mortality ICD9 390-459 ICD10 I00-I99	Ozone Maximum 8 h Summer	RR= 1.0046 (1.0022-1.0073) ?10µg/m^3	Gryparis et al 2004 (APHEA 2)

[1] Cambra K, Alonso E, Cirarda FB, Martínez-Rueda T. Bilbao APHEIS group. Selection of outcomes and exposure response functions for health impact assessment of particles and ozone. Review of the evidence. ENHIS project. WORK PACKAGE 5. Bilbao, February 2005. :

[2] Ferran Ballester: Valencian School of Health Studies, Valencia, Spain; Sylvie Cassadou: National Institute of Public Health Surveillance, InVS, Toulouse, France; Fintan Hurley: Institute of Occupational Medicine, Edinburgh, Scotland, UK; Nino Künzli: University of Southern California, Division of Occupational and Environmental Health, Los Angeles, CA, USA; Odile Meckel: Institute of Public Health NRW (LOEGD), Bielfeld, Germany; Hans-Guido Mücke: WHO Collaborating Center (Air)-Federal Environmental Agency, Berlin, Germany; Nikolaos Stilianakis: Institute for Environment and Sustainability, European Commission – JRC, Ispra, Italy.

To be coherent with mortality findings, it was decided, with the experts' advice, to include RRs of hospital admissions in the health impact assessment calculations, even if they were not statistically significant. More concretely, it was decided that if there was not any new RR published by the time of making the calculations, the RRs for respiratory hospital admissions from Anderson's meta-analysis could be used, although they were not statistically significant (see Table 2). The rationale for that is that if there is sufficient evidence to accept a causal relationship between air pollution and respiratory mortality -both in children-PM and adults-O_3- we should easily accept that there will also be an impact on hospital admissions.

Table 4. Complementary Exposure-response functions (ERFs) for health impact assessment on respiratory hospital admissions for children (particles) and adults (ozone)

OUTCOME	POLLUTANT	RR	SOURCE
CHILDREN - PARTICLES			
Respiratory hospital admissions 0-14 Y ICD9 460-519 ICD10 J00-J99	*PM_{10}* Daily Mean	*RR= 1.010 (0.998-1.021) ?10µg/m³*	*Anderson 2004*
ADULTS/GENERAL POPULATION			
Hospital respiratory admissions 15-64 Y ICD9 460-519 ICD10 J00-J99	*Ozone Maximum 8 h*	*RR=1.001 (0.991-1.012) ?10µg/m³*	*Anderson et al 2004*
Hospital respiratory admissions >64 Y ICD9 460-519 ICD10 J00-J99	*Ozone Maximum 8 h*	*RR=1.005 (0.998-1.012) ?10µg/m³*	*Anderson et al 2004*

Finally, HIA needs defining the evaluation scenarios, i.e. the hypothetical scenario with which we want to compare the current air pollution situation. We calculate the impact on health of the (current) air pollution levels in the city that are above the pollution level of the evaluation scenario. In other words, the attributable number of health events (deaths, hospital admissions…) calculated for each scenario represents the number of events that would be prevented if, all other things being constant, air pollution levels were reduced to the evaluation scenario level. These evaluation scenarios are based on the objectives and limits established in 1999/30/CE, and 2002/3/CE Directives.

HIA scenarios

1.- HIA scenarios of PM_{10}

1.1.- Scenarios for HIA on **short-term** effects of PM_{10} and **cough, lower respiratory symptoms** in people under 18 year (<18), and **hospital respiratory admissions** in people under 15 year (< 15)

1.1.1 Reduction of PM_{10} levels to a 24-hour value of **50 µg/m³** in all days exceeding this value (Limit of 1999/30/CE Directive)

1.1.2. Reduction of PM_{10} levels to a 24-hour value of **20 µg/m³** in all days exceeding this value

1.1.3 Reduction **by 5 µg/m³** of all the 24-hour values

1.2.- Scenarios for HIA on **long-term** effects of PM_{10} and **postneonatal mortality** (total, respiratory and sudden infant death syndrome-SIDS)

1.2.1 Reduction of the annual mean value of PM_{10} to a level of **40 µg/m³** (Limit of 1999/30/CE Directive for 2005)

1.2.2 Reduction of the annual mean value of PM_{10} to a level of **20 µg/m³** (Limit of 1999/30/CE Directive for 2010)

1.2.3 Reduction **by 5 µg/m^3** of the annual mean value of PM_{10}

2.- HIA scenarios on short-term effects of Ozone

2.1 Daily maximum 1-hour concentration and **emergency room visits for asthma** in people under 18 year (< 18)

2.1.1 Reduction of O_3 daily maximum 1-hour concentrations to a level of **180 µg/m^3** in all days exceeding this value (Information threshold of 2002/3/CE Directive)

2.1.2 Reduction **by 10 µg/m^3** of the daily maximum 1-hour concentrations

2.2 Daily maximum 8-hour moving average concentration and **mortality** in general population

2.2.1 Reduction of O_3 daily maximum 8-hour moving average concentrations to **120 µg/m^3** in all days exceeding this value (Limit for health protection of 2002/3/CE Directive)

2.2.2 Reduction **by 10 µg/m^3** in the daily maximum 8-hour moving average concentrations.

Findings

The annual number of postneonatal deaths attributable to PM_{10} levels higher than 20 ?g/m^3 was 0.5 (CI: 0.23-0.83), which is equivalent to an annual rate of 10.3 deaths per 100000 (CI: 4.6-16.5). In 2002 there was not any postneonatal death from respiratory causes, either any from SIDS, so that the number of attributable cases for these specific causes is 0. In the same year, 14.80 emergency respiratory admissions were attributable to the daily PM_{10} levels above 20 µg/m^3 (CI: (-2.9)-31.6). A reduction of 5 µg/m^3 in everyday PM_{10} average level would imply avoiding 3.14 (CI: (-0.69)-6.57) admissions per year.

Table 5 Potential benefits of reducing PM_{10} levels. Absolute number and number per 100000 children (95% confidence limits) attributable to the effects of PM_{10}.

	PM_{10}	**Attributable cases per year**	**Attributable cases /100.000 per year**
POSTNEONATAL MORTALITY	**Annual mean levels**		
Total	by 5 µg/m^3	0.12 (0.05-0.18)	2.38 (0.99-3.57)
	to 20 µg/m^3	0.52 (0.23-0.83)	10.31 (4.56-16.46)
	to 40 µg/m^3	0.08 (0.04-0.12)	1.59 (0.79-2.38)
Respiratory	by 5 µg/m^3	0	0
	to 20 µg/m^3	0	0
	to 40 µg/m^3	0	0
SIDS	by 5 µg/m^3	0	0
	to 20 µg/m^3	0	0
	to 40 µg/m^3	0	0
MORBIDITY	**Daily levels**		
Cough <18 y	by 5 µg/m^3	not available	not available
	to 20 µg/m^3		
	to 50 µg/m^3		
LRS <18 y	by 5 µg/m^3	not available	not available
	to 20 µg/m^3		
	to 50 µg/m^3		
Hospital respiratory admissions <15 y	by 5 µg/m^3	3,14 ((-0.63) - 6.57)	18.82 ((-3.70) - 40.21)
	to 20 µg/m^3	14.80 ((-2.91) - 31.61)	4.63 ((-0.91) - 9.84)
	to 50 µg/m^3	3.64 ((-0.72) - 7.74)	3.99 ((-0.80) - 8.36)

Table 6. Potential benefits in general population of reducing ozone daily levels. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of ozone.

	OZONE	Attributable cases per year	Attributable cases /100.000 per year
MORTALITY	**Daily 8-h max**		
Total excluding external	by 10 µg/m^3 to 120 µg/m^3	8.99 (4.93- 15.08) NA	1.27 (0.70-2.13) NA
Cardiovascular	by 10 µg/m^3 to 120 µg/m^3	4.29 (2.05- 6.81) NA	0.61 (0.29-0.96) NA
Respiratory	by 10 µg/m^3 to 120 µg/m^3	3.55 (2.32- 4.74) NA	0.50 (0.33-0.67) NA
MORBIDITY	**Daily 1-h max**		
Emergency room visits for asthma <18 y	by 10 µg/m^3 to 180 µg/m^3	not available	not available
	Daily 8-h max		
Hospital respiratory admissions 15-64 y	by 10 µg/m^3 to 120 µg/m^3	0.69 ((-6.22) - 8.29) NA	0.14 ((-1.26) - 1.68) NA
Hospital respiratory admissions > 64 y	by 10 µg/m^3 to 120 µg/m^3	8.20 ((-3.28) - 19.69) NA	6.04 ((-2.42) - 14.51) NA

NA: Not applicable

Relating to short term effects of O_3, each reduction of 10 µg/m^3 in maximum daily 8-hour moving average concentrations would delay 9 (CI: 5-15) deaths/year in the study area, 4 (CI: 2-7) from cardiovascular diseases, and 4 (CI: 2-5) from respiratory causes. The number of attributable emergency respiratory hospital admissions of people aged 15 to 64 years would be 0.69 (CI:(-6.22)-8.29)), and of people over 64 years 8.2 (CI: (-3.28)-19.69)). There was not any day with maximum daily 8-hour moving average concentration above 120 µg/m^3 and consequently there is not any attributable case.

Discussion

Like in other developed regions, infant mortality rates are very low in the Basque Country. Five postneonatal deaths occurred in 2002, and none of them were caused by respiratory diseases or SIDS. Although the evidence of causality of the relationship between AP and postneonatal respiratory mortality is sufficient (WHO, 2004), postneonatal mortality does not seem to be a sensitive indicator to assess the impact of suspended particles on children health. Despite RRs being quite large, the number of deaths are so low that hardly any attributable number of cases can be meaningful.

The hospital respiratory admissions in children under 15 represents a short term effect of suspended particles. As the RR is not statistically significant, the lower limit of the confidence interval of the attributable cases is negative. More prevalent and specific health outcomes are to be assessed. For the time being, in Bilbao area there are not suitable records of emergency room visits for asthma, neither LRS and cough prevalence data. Adverse effects of AP on lung function development have been demonstrated, but the scientific evidence to assess it is still scarce, and further research is needed.

There is a question related to the behaviour of ozone as a pollutant that can not be neglected. In urban areas, like our study area, ozone levels are lower than on the periphery of the city and in some parts of the countryside, places where urban citizens may actually go to on a regular basis, particularly in summertime. A consequence of this is that the use of urban average ozone levels may underestimate the actual exposure.

Ozone levels in Bilbao in 2002 area were not high and fulfilled the requirements of 2002/3/CE Directive. As there was no days with a maximum daily 8-hour moving average concentration above the limit of 120 µg/m^3 established in 2002/3/CE Directive, only the scenario of reduction of 10 µg/m^3 has been used. For each reduction of 10 µg/m^3 in maximum daily 8-hour moving average concentrations 9 deaths (1 death/100000) would be prevented. Taking into account the fact that in sum mer the mean of the maximum daily 8-hour moving average concentrations is 59 µg/m^3, it does not seem that any feasible reduction in urban ozone levels would produce a large reduction in mortality, at least as long as short term effe cts of ozone are concerned. The magnitude of the central estimate of respiratory admissions (8,69 for the two age groups) is only two and a half times higher than the number of attributable deaths. Although the RR used are not statistically significant, we would have expected this ratio to be higher in a place like Bilbao, with a highly developed health service in which practically the 100% of the emergency admissions are recorded. This question may be suggesting that hospital admissions RRs are not as trans ferable as mortality RRs, and that probably differences in the organization of the Heath Systems and Registers among cities are important.

There is also a need to assess other outcomes related to symptoms, in both general population and children. The lack of suitable exposure-response functions for children outcomes has prevented to include such evaluations in this report, although the evidence of causality for some of them, such asthma, has been considered sufficient (WHO, 2004).

Ozone and particle levels are not usually correlated, and their effects have been considered independent. Although non chronic effects of ozone have been assessed, the impact of particles on general population mortality in Bilbao urban area is larger than the calculated for ozone. As reported by Apheis-3, the chronic effects of particles are responsible for the main part of premature deaths and reduction of life expectancy life. We believe, thus, that the benefits of reducing particles levels in order to achieve the goal established in 1999/30/CE for 2010 (i.e. 20 µg/m^3 as an annual mean) would imply a larger benefit than the expected from a feasible reduction in ozone levels.

References

ANDERSON R, ATKINSON R, PEACOCK JL, MARSTON L AND KONSTANTINOU K Metaanalysis of time-series and panel studies on Particulate Matter and Ozone (O_3). WHO Task Group. WHO Regional Office for Europe, Copenhagen 2004 (EUR/04/5042688).

APHEIS 3. Health Impact Assessment of Air Pollution and Communication Strategy. Third Year Report 2002-2003. July 2004. Available in:
http://europa.eu.int/comm/health/ph_projects/2001/pollution/fp_env_2001_frep_en.pdf

CARB 2004. California Air Resources Board. Quantifying the health benefits of reducing ozone exposure. Available in http://www.arb.ca.gov/research/aaqs/ozone-rs/ch10.pdf

GRYPARIS A, ET AL. Acute effects of ozone on mortality from the "Air Pollution and health: A European Approach" Project. *Am J Respir Crit Care Med*. Vol 170: 1080-1087. (2004)

LACASAÑA M, ESPLUGUES A AND BALLESTER F. Exposure to ambient air pollution and prenatal and early childhood health effects. *European Journal of Epidemiology* 20: 183-189. (2005).

OFFICIAL JOURNAL OF THE EUROPEAN COMMUNITIES. Directive 1999/30/CE of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air. DOCE L163, 29/6/1999.

OFFICIAL JOURNAL OF THE EUROPEAN COMMUNITIES. Directive 2002/3/EC of 12 February 2002 relating to ozone in ambient air. DOCE L67/14, 9/03/2002.

WARD DJ, AND AYRES J G. Particulate air pollution and panel studies in children: a systematic review. Occup Environ Med. 61(4): e 13. Review. (2004).

WHO The effects of air pollution on children's health and development: a review of the evidence. Executive Summary. Available in: http://www.euro.who.int/document/EEHC/e xecsum.pdf

WOODRUFF TJ ET AL : The relationship between selected causes of postneonatal infant mortality and particulate air pollution in the United States. Environ Health Perspect 1997, 105: 608-612. http://ehp.niehs.nih.gov/members/1997/105-6/woodruff.html