Appendix 5

Health Impact Assessment of Outdoor Air Pollution

Template for the LOCAL CITY REPORT

City Name

Summary of main findings for city name

In 200- the PM_{10} annual mean (SD) was xx (xxx) µg/m^3, above/below the 1999/30/EC Directive limit value for 2010 (20 µg/m^3), and below/above that established for 2005 (40 µg/m^3). For the summer period of the same year, the mean (SD), P5 (5th percentile) and P95 of the maximum daily 8-hour moving average concentration of ozone (O_3) were xx(xxx), xx and xx µg/m^3.

Regarding children, infant mortality in Europe is quite low and consequently, the expected attributable number of deaths related to air pollution is also very low. All other things being equal, the reduction of the annual average levels of PM_{10} to 20 µg/m^3 would prevent xxxx total postneonatal deaths. Reducing PM_{10} daily mean values to 20 µg/m^3 would prevent xxx emergency room visits for asthma, yyy coughs, zzz lower respiratory symptoms and www hospital respiratory admissions.

As far as short-term effects of O_3 in summer are concerned, all other things being equal, each reduction by 10 µg/m^3 of the daily maximum 8-hour moving average concentrations would delay xxxx deaths per year in the general population in the study area, xxxx from cardiovascular diseases, and xxxx from respiratory causes. In terms of hospital admissions, this would represent xxx respiratory admissions in the adult population and yyy in the population over 64 years.

Summary of HIA of outdoor air pollution in city name in ENHIS-1

Health outcome	**Population**	**Pollutant**	**Period**	**Mean type**	**RR (for 10 µg.m^3 increase)**	*References*	**Number of attributable cases by scenario[1]**	
Mortality							**Ozone: Reduction by 10 µg.m^3**	**PM10: Reduction by 5 µg/m^3**
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	xxxxxxxx	
Cardiovascular mortality (ICD9 390-459 - ICD10 I00-I99)					1.0046 (1.0022-0.0073)		xxxxxxxx	
Respiratory mortality (ICD9 460-519 - ICD10 J00-J99)					1.0113 (1.0074-1.0151)		xxxxxxxx	
Total postneonatal mortality	1 month-1 year	Corrected PM_{10}[3]	Year	Annual	1.048 (1.022-1.075)	Lacasaña et al 2005		xxxxxxxx
Postneonatal respiratory mortality (ICD9 460-519 - ICD10 J00-J99)					1.216 (1.102-1.342)			xxxxxxxx
Postneonatal Sudden Infant Death Syndrom Mortality (ICD9 798.0 - ICD10 R95)					1.12 (1.07-1.17)	Woodruff 1997		xxxxxxxx
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	xxxxxxxx	
Cough	< 18 years	Measured PM_{10}			1.0407 (1.0202-1.0511)	Ward and Ayres 2004		not available
Lower resp iratory symptoms LRS	< 18 years	Measured PM_{10}			1.0407 (1.0202 -1.617)	Ward and Ayres 2004		xxxxxxxx
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	< 15 years	Measured PM_{10}			1.010 (0.998-1.021)	Anderson et al 2004		xxxxxxxx
Hospit al respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	15 - 64 years	**O_3 8h max**	Summer		1.001 (0.991-1.012)		xxxxxxxx	
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	> 64 years				1.005 (0.998-1.012)		xxxxxxxx	

[1] For ozone: absolute reduction by 10 µg/m^3. For PM_{10}: absolute reduction by 5 µg/m^3.

[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}. If the local air quality network uses automatic methods (TEOM or other) a correction factor is required to compensate for loss of volatile compounds: if available, a local correction factor recommended by the air quality network or, by default, the European factor 1.3.

Note: please don't forget to indicate not available in the cells for which you don't have the data

Introduction *(please describe the following issues)*

- General description of the study area, and its air pollution (AP) situation
- Main causes of mortality and morbidity in your city in general and with a special focus on children
- Previous health impact assessment (HIA) of air pollution carried out in the study area (Apheis 2 and 3, other…) (New HIAs like the one done for Apheis 3 for the new centres) : main results
- Presentation of the report plan: list of results that are presented in the report: HIA results in children, and in the general population, in adults and in population over 64 years, for PM10 and ozone.
- This work has been carried out within the framework of work package WP5 on health impact assessment of ENHIS-1 project (www.enhis.net).

Sources of air pollution

Give the information available about air pollution sources, emissions and evolution of AP levels in your city.

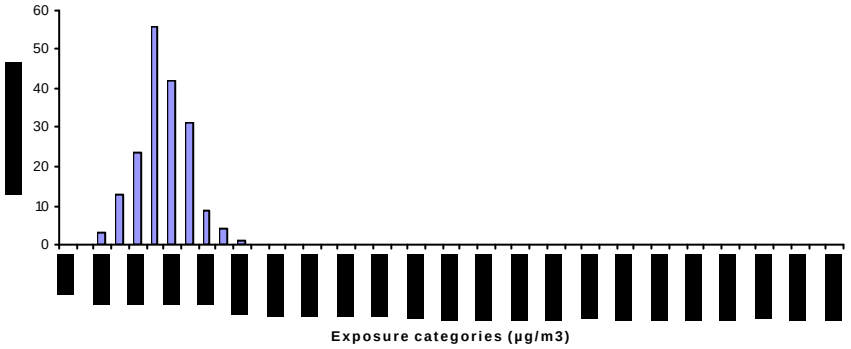
Exposure data

- Source of the AP data, number of monitoring stations for particles and ozone, analytical methods, correction factor used to compensated losses of volatile compounds (if used)
- How indicators have been calculated:
  - PM_{10}: daily exposure indicator has been calculated as the arithmetic mean of the daily concentrations of the stations.
  - Ozone: the daily maximum 1-hour indicator has been calculated as the arithmetic mean of the 1-hour maximum of the stations. The daily maximum 8-hour moving average of each day have been calculated as the arithmetic mean of the maximum 8hour moving averages of the stations for the summer period (1st April to 30th September)" .
- AP data description: The annual mean level (SD) of PM10 in city name was xxx (xxx) µg/m^3, and P5 and P95 of the daily mean values were, respectively, xxx µg/m^3 and xxx µg/m^3. The mean (SD) , P5 and P95 of the daily maximum 8-hour moving average concentrations of O_3 were, respectively, xxx, xxx and xxx µg/ m^3, and those of the daily maximum 1-hour concentrations xxx, xxx and xxx µg/m3 (Table 1 and figures 1-3) (data from Bilbao as an example)
- Comments on the magnitude of the values compared to the Directives limit values
- Comment figures 1, 2 and 3. on number of days with different air pollution levels.

Table 1. Descriptive statistics for ozone and PM_{10} levels in place/city and year

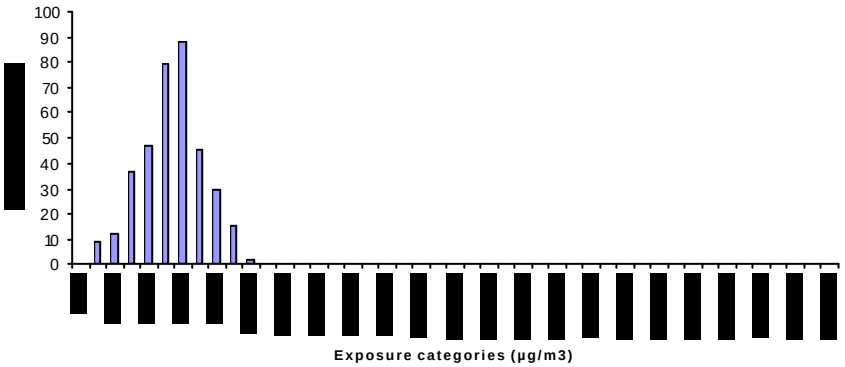
	O3 8h - summer	O3 1h max - year	PM10 - year
Number			
Minimum			
Percentile 5			
Percentile 25			
Median			
Percentile 75			
Percentile 95			
Percentile 98			
Maximum			
Daily mean			
standard error			
% missing values			

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

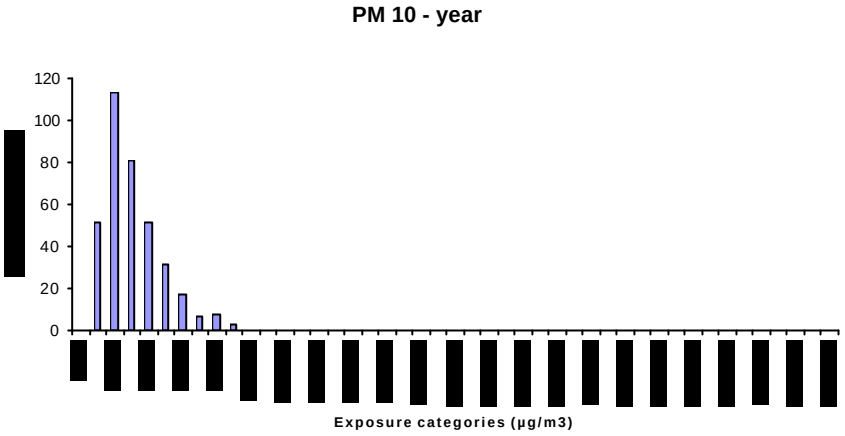


Please complete the title of Figure 2 in your EIS PA file in the same way that Bilbao example before copying it as an image in this word document

O3 1h max - year



Please complete the title of Figure 3 in your EIS PA file in the same way that Bilbao example before copying it as an image in this word document



Health data

- Source of mortality data, year, type of register, quality control programme and completeness
- Idem for other indicators used: hospital admissions, emergency room visits, lower respiratory symptoms cough.
- Which outcomes of table 3 (see below) were not included in the HIA? . Reasons ?

Describe the health outcomes analyzed for your HIA that are shown in Table 2: in terms of number of cases and rates per 100 000.

Table 2. Descriptive statistics for health outcomes in place/city and year

Health outcome	ICD9	ICD10	Annual deaths	Annual rate (per 100 000)	Daily mean (SD)	Daily rate (per 100 000)	Annual incidence rate (per 100 000)
POSTNEONATAL MORTALITY							
Total			xxx	xxx			
Respiratory *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99	xxx	xxx			
Sudden infant death syndrome *ICD9 798.0 – ICD10 R95*	798.0	R95	xxx	xxx			
GENERAL POPULATION MORTALITY							
Total mortality all causes *ICD9 <800 ICD10 A00-R99*	<800	A00-R99			xxx	xxx	
Cardiovascular mortality *ICD9 390-459 ICD10 I00-I99*	390-459	I00-I99			xxx	xxx	
Respiratory mortality *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99			xxx	xxx	
MORBIDITY							
Cough					not available		
Lower respiratory symptoms LRS					not available		
Emergency room visits for asthma - Age < 18 years *ICD9 493, ICD10 J45 J46*	493	J45-J46			xxx	xxx	
Hospital respiratory admissions - Age < 15 years *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99					xxx

Hospital respiratory admissions - Age 15-64 years	460-519	J00-J99	xxx
Hospital respiratory admissions - Age > 64 years	460-519	J00-J99	xxx

Note: please don't forget to indicate not available in the cells for which you don't have the data

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. A causal relationship between AP and the effects is assumed, and therefore 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)

[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. Http:

[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, Div ision 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.

	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)

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 assesment 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/m^3*	*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/m^3*	*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/m^3*	*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 equal, 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 for 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/m^3** 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/m^3** in all days exceeding this value

1.1.3 Reduction **by 5 µg/m^3** 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/m^3** (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/m^3** (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

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

1.2.1.1 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)

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

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

1.2.2.1 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)

1.2.2.2 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 xxx (95%CI: xxx - xxx), which is equivalent to an annual rate of xxx deaths per 100 000 (95%CI: yy-zz).

Table 5. Potential benefits of reducing PM_{10} levels. Absolute numbers and rates (per 100 000 children) (95% confidence limits) attributable to the health effects of PM_{10}.

	PM10 reduction	**Number of attributable cases per year**	**Annual rates (per 100.000)**
POSTNEONATAL MORTALITY	**Annual mean levels**		
Total	by 5 µg/m^3	0,12 (0,05-0,18)	0.02 (0.01-0.03)
	to 20 µg/m^3	0,52 (0,23-0,83)	0.07 (0.03-0.12)
	to 40 µg/m^3	0,08 (0,04-0,12)	0.01 (0.01-0.02)
Respiratory	by 5 µg/m^3	not available	not available
	to 20 µg/m^3	-	-
	to 40 µg/m^3	-	-
SIDS	by 5 µg/m^3	-	-
	to 20 µg/m^3	-	-
	to 40 µg/m^3	-	-
MORBIDITY	**Daily levels**		
Cough <18 y	by 5 µg/m^3		
	to 20 µg/m^3		
	to 50 µg/m^3		
LRS <18 y	by 5 µg/m^3		
	to 20 µg/m^3		
	to 50 µg/m^3		
Hospital respiratory admissions <15 y	by 5 µg/m^3		
	to 20 µg/m^3		
	to 50 µg/m^3		

Note: please don't forget to indicate not available in the cells for which you don't have the data

Regarding short-term effects of O_3, each reduction by 10 µg/m^3 of daily maximum 8-hour moving average concentrations would delay xxx (95%CI: xxx - xxx) deaths per year in the study area, xxx (95%CI: xxx - xxx) from cardiovascular diseases, and xxx (95%CI: xxx - xxx) from respiratory causes.

Table 6. Potential benefits of reducing ozone daily levels. Absolute numbers and rates (per 100 000 inhabitants) (95% confidence limits) attributable to the health effects of ozone.

	OZONE reduction	**Number of attributable cases per year**	**Annual rates (per 100.000)**
MORTALITY	**Daily 8-h max**		
Total excluding external causes	by 10 µg/m^3	8,99 (4,93- 15,08)	1,27 (0,70-2,13)
	to 120 µg/m^3	NA	NA
Cardiovascular	by 10 µg/m^3	4,29 (2,05- 6,81)	0,61 (0,29-0,96)
	to 120 µg/m^3	NA	NA
Respiratory	by 10 µg/m^3	3,55 (2,32- 4,74)	0,50 (0,33-0,67)
	to 120 µg/m^3	NA	NA
MORBIDITY	**Daily 1-h max**		
Emergency room visits for asthma <18 y	by 10 µg/m^3	not available	not available
	to 180 µg/m^3	…..	
	Daily 8-h max		
Hospital respiratory admissions 15-64 y	by 10 µg/m^3		
	to 120 µg/m^3		
Hospital respiratory admissions > 64 y	by 10 µg/m^3		
	to 120 µg/m^3		

NA: Not applicable if air pollution levels are lower than the scenario level

Note: please don't forget to indicate not available in the cells for which you don't have the data

Discussion

Interpret your findings, compliance with EC Directive limits, study's limitations, magnitude of the public health impact of outdoor air pollution in your city compared with other risk factors, possible implications of the HIA findings for your city, measures taken in your city or country to reduce air pollution levels, citizens initiatives, National Environmental Health Action Plans (NEHAPs), etc.

Conclusion

Feel free to complete your conclusion!!!

References

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