HEALTH IMPACT ASSESSMENT OF AIR POLLUTION

ENHIS-1 PROJECT: WP5 HEALTH IMPACT ASSESSMENT

LOCAL CITY REPORT

Brussels

Summary of main findings for Brussels

In 2001- the PM_{10} annual mean (SD) was 24.9 (12.3) µg/m^3 (37 (18) µg/m^3 when a correction (1.47) is applied in order to compensate losses of volatile compounds due to the TEOM measurement method), above the 1999/30/EC Directive limit value for 2010 (20 µg/m^3), and below 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 74(30),31 and 135 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 1.80 total postneonatal deaths. Reducing PM10 daily mean values to 20µg/m^3 would prevent 20.83 hospital respiratory admissions of children under 15 year old.

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 13.91 deaths per year in the general population in the study area, 7.85 from cardiovascular diseases, and 5.97 from respiratory causes. In terms of hospital admissions, this would represent 0.42 respiratory admissions in the adult population and 7.23 in the population over 64 years.

Summary of HIA of outdoor air pollution in Brussels 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	13.91	
Cardiovascular mortality (ICD9 390-459 - ICD10 I00-I99)					1.0046 (1.0022-0.0073)		7.85	
Respiratory mortality (ICD9 460-519 - ICD10 J00-J99)					1.0113 (1.0074-1.0151)		5.97	
Total postneonatal mortality	1 month- 1 year	Corrected PM_{10}[3]	Year	Annual	1.048 (1.022-1.075)	Lacasaña et al 2005		0.56
Postneonatal respiratory mortality (ICD9 460-519 - ICD10 J00-J99)					1.216 (1.102-1.342)			0.09
Postneonatal Sudden Infant Death Syndrom Mortality (ICD9 798.0 - ICD10 R95)					1.12 (1.07-1.17)	Woodruff 1997		0.44
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	1.19	
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		20.83
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	15 - 64 years	**O_3 8h max**	Summer		1.001 (0.991-1.012)		0.42	
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	> 64 years				1.005 (0.998-1.012)		7.23	

[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 (the Brussels network recommended 1.47) or, by default, the European factor 1.3.

Introduction

- The study area covers the Capital Region of Brussels. It includes 19 local authorities, representing a total area of 161 km^2. The population living in this area is estimated to around 1million inhabitants. The population density differs widely between local authorities with respect to population characteristics, housing and socio-economic status. The region has no heavy industries, it concentrates a large number of administrations and state institutions due to its activities as national and European capital, transportation infrastructures, and one international airport is located at its outskirts. However, green surfaces occupy 53% of the territory.

- Air quality is monitored since the '60s. A "Regional Air Quality Action Plan" has been adopted by the Brussels Parliament in November 2002, it integrates 81 actions.

  The Brussels Institute for the Management of the Environment (BIME) has a network of measurement stations that continuously record the concentration of pollutants in the air. Based on these findings, two indices provide a snapshot of the quality of the air we breathe in the Brussels Region since 1996. Dynamic information on air quality is available for the public via Internet (www.ibgebim.be) and on panels located on main road or tunnels (pollumeter). The Pollumeter displays two dynamic indices in the form of scales from 1 to 10, updated in real-time (every hour), and are averaged over the last 24 hours. The global index is calculated by bringing together data measured at 10 stations indicating ozone (0_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and suspended particulates (PM_{10}). It provides an estimate of the entire Region's air quality. The traffic index conveys pollution in areas close to road traffic, based on data of nitrogen oxides (NO_2) and carbon monoxide (CO). Emissions mainly come from car traffic, heating and a number of other miscellaneous sources.

  In the study area, levels of sulfur dioxide have been very low for several years. There are no industrial sources of sulfur dioxide but we should still take into account traffic related sources. Traffic remains the major source of carbon monoxide in the study area. Levels have decreased following the implementation of yearly compulsory technical inspection of cars and trucks. Benzene levels are also decreasing. Particular air pollution levels have been steady for the last years. PM monitoring during the "European days without cars" shows the influence of wind and humidity on PM_{10} and no influence on $PM_{2,5}$. Nitrogen dioxide levels have been steady for the last 5 years. Ozone levels show a slight increase. In general the air quality is considered as good even though when inhabitants participate in surveys, 30% of them consider the quality of the air as very bad.

- In the study area, life expectancy is close to the mean for Belgium. Life expectancy of women is median and of men is weak. There are differences within the study area, socio-economic factors and poverty play a major role. The age structure of the population is quite different from the rest of Belgium, the age structure is younger in Brussels due to a large migrant population with a different age structure. Birth rate is higher than in other regions of Belgium, and infant mortality (children aged less than one year) is relatively high compared to other European countries and regions .

  The main causes of mortality of the general population are cardio-vascular diseases (36%) and cancers (25%). Respiratory diseases is the third cause of mortality (12%).

  Infant mortality has been decreasing slightly for the last years, but remain higher in Brussels than in the rest of Belgium. The main cause of infant mortality around birth arises from congenital problems. Sudden infant death syndrome (SIDS) is the most important cause of mortality during the post-neonatal period (28days to 1year of age).

Meanwhile, SIDS has been decreasing with the implementation of prevention measures and information to target populations since the years ’90s.

Concerning older children and adolescents younger than 20 years of age, if we exclude mortality related to external causes (accidents, suicides, … = 46%), cancers (15%) becomes the most important cause of mortality. It is followed by infections (7%), metabolic (5%) and congenital anomalies (4%).

Cardiovascular mortality concerns the oldest part of the general population and is its major cause after 75years. Cancer remains the major cause for earlier mortality (mortality before the age of 65), it is the first cause of mortality in the age group between 45 and 75.

- Air pollution health impact assessments (HIA) have not been carried out in the study area using the APHEIS methodology, this report is the result of the first HIA carried out in this framework.
- This report presents results obtained for the Brussels study area. After a brief description of air pollution sources, exposure and health data, the results of the HIAs conduced on postneonatal mortality, cardiovascular and respiratory mortality, and respiratory hospital admissions in relation with ozone (short-term) and PM10 (short- and long-term) are presented
- 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

Brussels has no heavy industry. Emissions mainly come from car traffic, heating and a number of other miscellaneous sources.

The main source of nitrogen oxides within the study area is road traffic. According to the inventory of emissions for the year 2001, road traffic, together with other mobile sources, represents 57% of the NO_X emissions (State of the Environment for the Brussels-Capital Region, 2004).

Particulate matter come from several sources among those localized or mobile sources related to combustion processes, recombination of gaseous pollutants such as VOC, NO_X, SO_X and NH_3 present in the atmosphere and indirect sources due to pollutants transport and weather conditions. Within particulate matter several size groups are important, it is accepted that smaller particles (0.1-0.01µm) are potentially more toxic. In some weather conditions PM_{10} might represent 60-70% of the total PM (see results of European day without cars, in Report on air quality in the Brussels-Capital Region, 2000-2002). There is no inventory of PM sources for the Brussels-Capital Region in 2001.

Transport, in 2001, was accountable for 90.5% of CO emissions, 89.6% of HAP emissions, 57% of NO_X emissions, 45.8% of lead emissions and 41.2% of non-methane volatile organic compounds (NMVOC).

Heating, in 2001, was accountable for 68.8% of CO_2 emissions, 89.7% of SO_X emissions and 32.2% of N_2O emission.

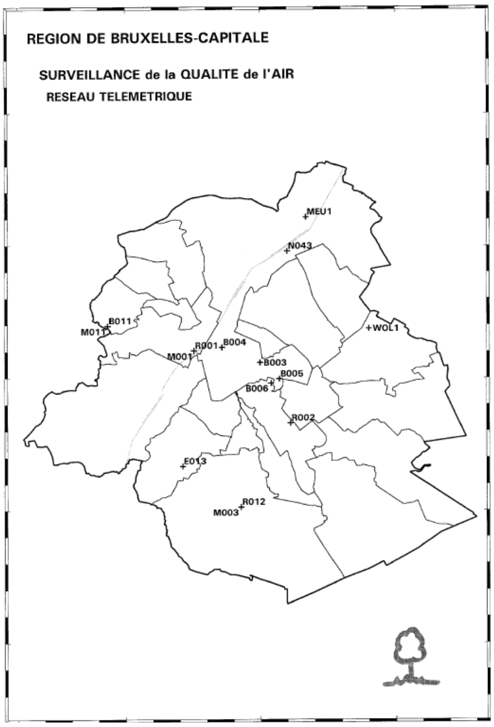
Exposure data

Air pollution levels is monitored by the Research Laboratory on Environment of the BIME. Within the study area, a monitoring network has been set up and monitors levels of several pollutants.

In 2001, 5 background monitoring stations measured, by UV absorption, the levels of ozone (R001, B011, R012, N043, B004 and B006). 6 background monitoring stations (TEOM) measured the levels of PM10 (R001, B011, R012, N043, and MEU1), and 3 background monitoring stations measured levels of PM2,5 (MEU1, R001 and N043). The figure 0 shows the location of the monitoring stations.

A comparison between the 3 regional air quality monitoring network (Brussels, Walloon and Flanders) allowed to define a correction factor of 1.47, in order to compensate losses of volatile compounds. This correction factor is used for HIA.

Figure 0: localization of background monitoring stations in the Brussels study area.



- 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 concentration and the daily maximum 8-hour moving averages of each day have been calculated for the summer period (1st April to 30th September).
- AP data description:

  The annual mean (SD) of TEOM PM_{10} in Brussels was 24.9(12.3)µg/m^3, and P5 and P95 of the daily mean values were, respectively, 12.2 µg/m^3 and 44.2 µg/m3.

  The annual mean level (SD) of corrected PM_{10} in Brussels was 36.6(18.1)µg/m^3, and P5 and P95 of the daily mean values were, respectively,18 µg/m^3 and 65 µg/m^3.

  The mean (SD), P5 and P95 of the daily maximum 8-hour moving average concentrations of O_3 were, respectively, 74 (30), 31 and 136 µg/ m^3, and those of the daily maximum 1-hour concentrations 60 (36), 9 and 142 µg/m^3 (Table 1 and figures 1-3).
- Following limits set in the Directive 1999/30/CE, both TEOM and corrected PM_{10} annual mean levels were lower in 2001 than the limit value for 2005 (40µg/m^3). However, both TEOM and corrected annual mean levels were higher than the limit value for 2010 (20µg/m^3). The number of exceeding PM_{10} daily values (50µg/m^3) per year was higher in 2001 (70) than the maximum number for 2005 (35) and than the maximum number for 2010 (7), (Table 1 and figure 3).

  Concerning ozone and following the Directive 2002/03/CE, the daily maximum 8-hour moving average has been higher than 120µg/m^3 during 23 days in 2001, whereas the target value for 2010 is that the 120µg/m^3 value should not to be exceeded on more than 25 days per calendar year averaged over 3 years. Daily levels of ozone (both 1-hour and 8-hour) show a large variability, but in Brussels the thresholds limits for population information (180µg/m^3 for 1-hour average) was never overshot, (Table 1 and figures 1 and 2).

Table 1. Descriptive statistics for ozone and corrected PM_{10} levels in Brussels (2001)

	O3 8h - summer	O3 1h max - year	Corrected PM10 - year
Number	183	365	365
Minimum	6	3	10
Percentile 5	31	9	18
Percentile 25	54	38	24
Median	70	55	33
Percentile 75	85	78	44
Percentile 95	136	142	65
Percentile 98	143	156	76
Maximum	159	182	194
Daily mean	74	60	37
standard error	30	36	18
% missing values	0.00%	0.00%	0.00%

Fig 1. Distribution of daily O3 8h max in Brussels area. Summer 2001

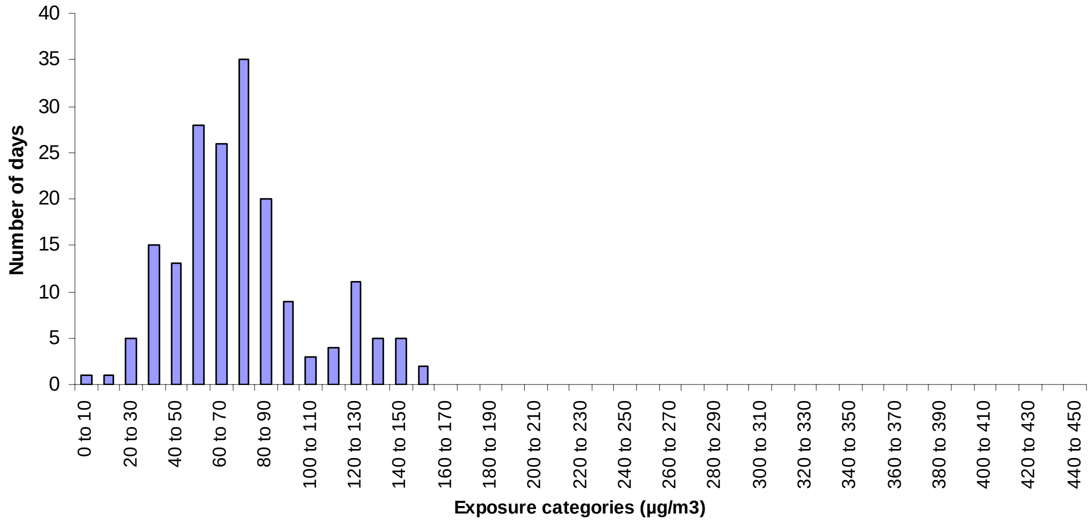


Fig 2. Distribution of daily O3 1h max in Brussels area. year 2001

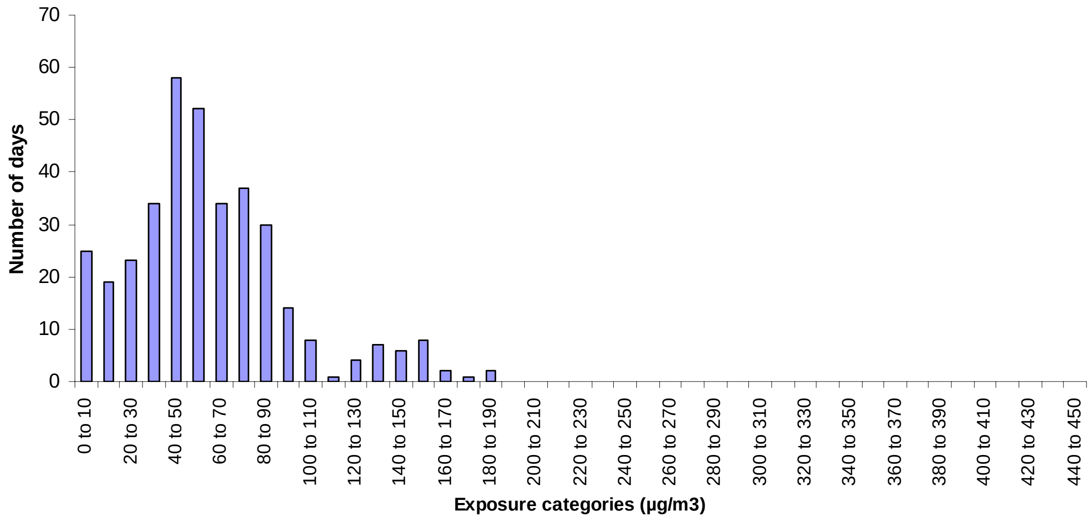
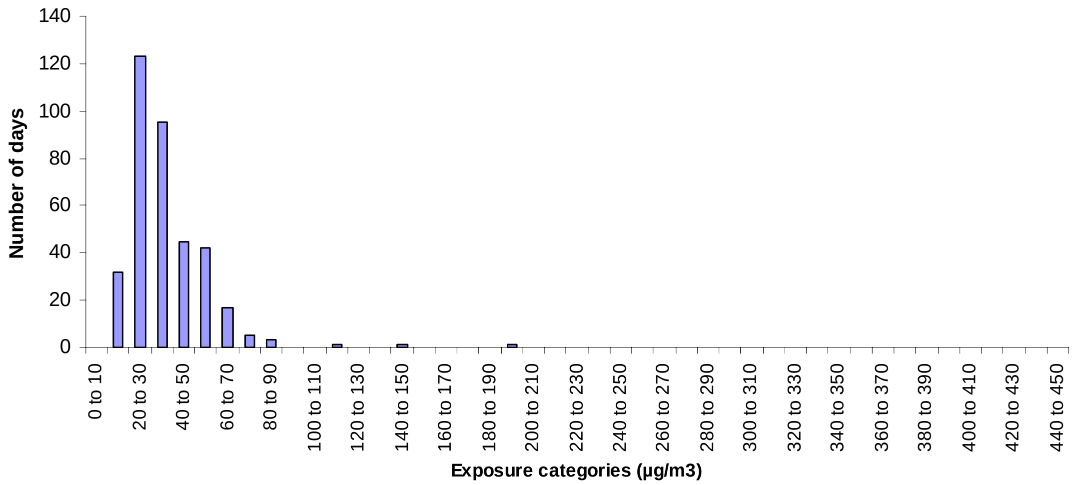


Fig 3. Distribution of daily PM 10 in Brussels area. Year 2001



Health data

Mortality data are obtained from death certificates. For each death, a certificate is fulfilled by the physician concerning health data and sent to the local administration. The certificate concerning Brussels inhabitants a sent to the regional observatory for public health that performs codification and quality control. Death causes were coded according to ICD-10.

Hospital admissions data concerned public and private hospitals, they were extracted from the information systems health programs (résumé clique minimum) by the Federal Ministry of Public Health. These data are total hospital admissions data and include both emergency and scheduled hospital admissions. Data for the year 2001, were provided by hospitals and coded according to ICD-09. Data on emergency room visits for asthma followed the same procedure.

Data concerning specific emergency hospital admissions, for cough or lower respiratory symptoms were not available in Brussels and HIA was not conducted on those indicators.

The total number of postneonatal deaths in 2001 was 24 (annual rate 157 per 100,000) , among which 1 were due to respiratory causes and 8 to sudden infant death syndrome.

The number of deaths in the general population (excluding external causes) was 25 (daily rate 2.6 per 100,000), among which 9.6 (daily rate 1 per 100,000) were due to cardiovascular causes, and 3.1 (daily rate 0.3 per 100,000) were due to respiratory causes.

The number of emergency room visits for asthma for young people (under 18 was 0.6 (daily rate 0.3 per 100.000).

The annual rate of respiratory hospital admissions was high in both young and elderly people: annual rate for children under 15 was 4309.7 per 100,000, and annual rate among people aged 65 and more was 2978.3 per 100,000. The annual rate for people age between 15 and 64 was really lower : 835.7 per 100,000.

Table 2. Descriptive statistics for health outcomes in Brussels 2001

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			24	157			
Respiratory *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99	1	7			
Sudden infant death syndrome *ICD9 798.0 – ICD10 R95*	798.0	R95	8	52			
GENERAL POPULATION MORTALITY							
Total mortality all causes *ICD9 <800 ICD10 A00-R99*	<800	A00-R99			25(5.2)	2.6	
Cardiovascular mortality *ICD9 390-459 ICD10 I00-I99*	390-459	I00-I99			9.6 (3.1)	1	
Respiratory mortality *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99			3.1 (1.7)	0.3	
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			0.6	0.3	
Hospital respiratory admissions - Age < 15 years *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99					4309.7
Hospital respiratory admissions - Age 15 -64 years	460-519	J00-J99					835.7
Hospital respiratory admissions - Age > 64 years	460-519	J00-J99					2978.3

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/m³	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/m³	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/m³	Woodruff et al. 1997
	Cough	PM_{10} Daily Mean	OR=1.041 (1.020-1.062) ↑10µg/m³	Ward & Ayres 2004
	Lower respiratory symptoms LRS	PM_{10} Daily Mean	OR=1.041 (1.020-1.051) ↑10µg/m³	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/m³	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/m³	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/m³	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/m³	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.

[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, 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.

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/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 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/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/m³** 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/m³** in all days exceeding this value (Information threshold of 2002/3/CE Directive)

1.2.1.2 Reduction **by 10 μg/m³** 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/m³** in all days exceeding this value (Limit for health protection of 2002/3/CE Directive)

1.2.2.2 Reduction **by 10 µg/m³** in the daily maximum 8-hour moving average concentrations.

Findings

When corrected PM10 levels were used as a measure of exposure:

The annual number of postneonatal deaths attributable to PM_{10} levels higher than 20 µg/m³ was 1.80 (95%CI: 0.82-2.83), which is equivalent to an annual rate of 11.77 deaths per 100 000 (95%CI: 5.36-18.51).

The annual number of postneonatal respiratory deaths attributable to PM_{10} levels higher than 20 µg/m³ was 0.28 (95%CI: 0.13 - 0.46), which is equivalent to an annual rate of 1.83 deaths per 100,000 (95%CI: 0.85 – 3.01).

The annual number of postneonatal SIDS deaths attributable to PM_{10} levels higher than 20 µg/m³ was 1.37 (95%CI: 0.79 – 1.97), which is equivalent to an annual rate of 8.96 deaths per 100,000 (95%CI: 5.17 – 12.89).

The annual number of hospital admissions for respiratory causes of children aged less than 15 attributable to PM_{10} levels higher than 20 µg/m³ was 12.07 (95%CI: -2.36 – 25.89), which is equivalent to an annual rate of 7.01 deaths per 100,000 (95%CI: -1.37 – 15.03).

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 corrected PM_{10}.

	PM10 reduction	**Number of attributable cases per year**	**Annual rates (per 100.000)**
POSTNEONATAL MORTALITY	**Annual mean levels**		
Total	by 5 µg/m³	0.56 (0.26-0.86)	3.66 (1.70-5.62)
	to 20 µg/m³	1.80 (0.82-2.83)	11.77 (5.36-18.51)
	to 40 µg/m³	NA	NA
Respiratory	by 5 µg/m³	0.09 (0.05-0.14)	0.589 (0.327-0.916)
	to 20 µg/m³	0.28 (0.13-0.46)	1.83 (0.85- 3.01)
	to 40 µg/m³	NA	NA
SIDS	by 5 µg/m³	0.44 (0.26-0.62)	2.88 (1.70-4.05)
	to 20 µg/m³	1.37 (0.79-1.97)	8.96 (5.17- 12.89)
	to 40 µg/m³	NA	NA
MORBIDITY	**Daily levels**		
Cough <18 y	by 5 µg/m³	Not available	Not available
	to 20 µg/m³	Not available	Not available
	to 50 µg/m³	Not available	Not available
LRS <18 y	by 5 µg/m³	Not available	Not available
	to 20 µg/m³	Not available	Not available
	to 50 µg/m³	Not available	Not available
Hospital respiratory admissions <15 y	by 5 µg/m³	20.83 (-4.18-43.62)	12.09 (-2.43-25.32)
	to 20 µg/m³	12.07 (-2.36-25.89)	7.01 (-1.37-15.03)
	to 50 µg/m³	1.29 (-0.25-2.79)	0.75 (-0.14-1.62)

Regarding short-term effects of O_3, each reduction by 10 µg/m³ of daily maximum 8-hour moving average concentrations would delay 13.91 (95%CI: 7.63 -23.33) deaths per year in the study area, 7.85 (95%CI: 3.75 -12.46) from cardiovascular diseases, and 5.97 (95%CI: 3.91 – 7.98) from respiratory causes.

Each reduction of 10µg/m³ of daily maximum 1-hour would delay 1.19 (95%CI: 0.69 – 1.70) emergency room visit for asthma of people younger than 18.

Each reduction by 10µg/m^3 of daily maximum 8-hour moving average concentrations would delay 0.42 (95%Cl: -3.75 – 5) respiratory hospital admission of people aged between 15 and 64, and 7.23 (95%Cl: -2.89 – 17.36) respiratory hospital admissions of people aged 65 and more.

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	by 10 µg/m^3	13.91 (7.63 - 23.33)	1.446 (0.794 – 2.426)
	to 120 µg/m^3	2.52 (1.38 - 4.23)	0.262 (0.143 – 0.498)
Cardiovascular	by 10 µg/m^3	7.85 (3.75 - 12.46)	0.816 (0.390 – 1.295)
	to 120 µg/m^3	1.45 (0.69 - 2.30)	0.1551 (0.0717 – 0.239)
Respiratory	by 10 µg/m^3	5.97 (3.91 - 7.98)	0.621 (0.406 – 0.830)
	to 120 µg/m^3	1.19 (0.78 - 1.59)	0.124 (0.081- 0.165)
MORBIDITY	**Daily 1-h max**		
Emergency room visits for asthma <18 y	by 10 µg/m^3	1.19 (0.69 - 1.70)	0.58 (0.34- 0.82)
	to 180 µg/m^3	NA	NA
	Daily 8-h max		
Hospital respiratory admissions 15-64 y	by 10 µg/m^3	0.42 (-3.75 - 5)	0.009 (-0.083 – 0.11)
	to 120 µg/m^3	0.07 (-0.66 - 0.89)	0.0015 (-0.0147 – 0.0198)
Hospital respiratory admissions > 64 y	by 10 µg/m^3	7.23 (-2.89 - 17.36)	4.5 (-1.8 – 10.8)
	to 120 µg/m^3	1.34 (-0.53 – 3.23)	0.83 (-0.33 – 2.01)

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

Discussion

These findings are based on both health data and environmental data for the year 2001.

Regarding health data, hospital admission data are extrated by programs that could lead to overestimations. Hospitals are financed based on the monitoring of hospital admissions and the pathologies represented. Each record would be minimalised and increase the number of new admissions for patient who should not have left the hospital. Hence the number of attributable hospital admissions are certainly over-estimated.

Regarding environmental data, the use ot TEOM and of a local correction factor of 1.47 for PM_{10} overestimates PM_{10} concentrations compared to other cities where 1.3 correction factor was used. The composition of PM_{10} and the large clay fraction (up to 60%) should be taken into consideration (Airborne particle dynamics in the Brussels environment, 2002).

In the Brussels study area, ozone levels, in 2001, are compliant with target value for 2010 (120µg/m^3 not to be exceeded on more than 25 days per calendar year averaged over 3 years). A small number of deaths (total, cardiovascular and respiratory) are attributable to daily ozone 8-h max levels above 120µg/m^3 (respectively 2.58, 1.45 and 1.19). Compliance with long term objectives for ozone and moreover, a reduction of daily 8-hour max levels of ozone by 10µg/m^3 would induce large health benefits in terms of mortality (respectively 13.91, 7.85 and 5.97 for total mortality, cardiovascular and respiratory mortality).

PM_{10} levels are compliant with 2005 limit values (40µg/m^3). No attribuatable case could be corresponding to a reduction of the annual mean to 40µg/m^3. However, a significant number of attributable postneonatal deaths could be reduced with a reduction of the annual mean by 5µg/m^3 and a reduction of the annual mean to 20µg/m^3. The number of postneonatal death attributalbe to PM_{10} levels higher than 20µg/m^3 has proven to be highly sensitive to the values used to assess exposure to PM_{10}. This represents a limitation to the use of HIA. Compliance with 2010 limit value for PM_{10} could induce health benefits. However the composition of PM_{10}, the influence of weather conditions and the observed large clay fraction would bring limitation to the faisability of the compliance. Another indicator of air quality and particulate matter ($PM_{2,5}$) might reflect in a better way the relation between exposure and health.

The number of attributable cases to ozone and PM_{10} might seem very small compared to other risk factors. It is important to understand that air quality exposure concerns the total population whether other risk factors might depend on personnal preferences or be mors easely controlled.

Brussels-Capital being as well a region with legislative power and an urban area, actions could be taken at a larger level. Moreover, the proposal has been put at the national environment and helath actions plan (NEHAP) in order to ensure access to health data, allow the develoment of a network of participating cities and the use of the ENHIS methodology to assess air quality policies and eventually transport related policies.

Conclusion

This report is the result of the first participation of the Brussels study area in HIA, it shows the potential use of HIA in assessing policies. However, data are requested to be representative and hypothesis solid. The use of such results requires precautions both for communication with decision-makers and with the general public. One year analysis does not give a full answer, such methodology is aimed to be done on a routine base with incremental additions and improvements.

For HIA, air quality is far from being the first cause of mortality, other risk factors have a larger influence. However, the whole population is exposed to outdoor air quality.

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