HEALTH IMPACT ASSESSMENT OF AIR POLLUTION

ENHIS-1 PROJECT: WP5 HEALTH IMPACT ASSESSMENT

LOCAL CITY REPORT

ROME

Summary of main findings for Rome

In 2004 the PM_{10} annual mean (SD) was 61.4 (21.7) µg/m^3, above the 1999/30/EC Directive limit value for 2010 (20 µg/m^3), and 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) were105.0 (28.2), 57.8 and 155.6 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 3.5 total postneonatal deaths. Reducing PM_{10} daily mean values to 20 µg/m^3 would prevent 180.8 hospital respiratory admissions in children below 15 yrs..

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 31.3 deaths per year in the general population in the study area,18.8 from cardiovascular diseases, and 5.7 from respiratory causes. In terms of hospital admissions, this would represent 2.3 respiratory admissions in the adult population (15-64 yrs.) and 19.6 in the population over 64 years.

* for international comparison, PM10 measurements have been corrected by a European default factor of 1.3 from the EC Working Group on Particulate Matter.

Summary of HIA of outdoor air pollution in Rome 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	31.25 (17.14-52.42)	
Cardiovascular mortality (ICD9 390-459 - ICD10 I00-I99)					1.0046 (1.0022-0.0073)		18.77 (8.98-29.79)	
Respiratory mortality (ICD9 460-519 - ICD10 J00-J99)					1.0113 (1.0074-1.0151)		5.70 (3.73-7.62)	
Total postneonatal mortality	1 month- 1 year	Corrected PM_{10}[3]	Year	Annual	1.048 (1.022-1.075)	Lacasaña et al 2005		0.46 (0.21-0.72)
Postneonatal respiratory mortality (ICD9 460-519 - ICD10 J00-J99)					1.216 (1.102-1.342)			0.09 (0.05-0.14)
Postneonatal Sudden Infant Death Syndrom 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		20.92 (-4.20-43.82)
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	15 - 64 years	**O_3 8h max**	Summer		1.001 (0.991-1.012)		2.31 (-20.82-27.76)	
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	> 64 years				1.005 (0.998-1.012)		19.58 (-7.83-47.00)	

[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.

Introduction

The metropolitan area of Rome has a population of 2,5 million inhabitants with 13 % below 15 years and 19% older than 65 years of age (2000, National Institute of Statistics) and covers an area of 1495 km^2. Most of the population (ca. 80%) lives in the city centre, which has been defined by the local authorities as the area of concern for air pollution control. The city centre (ca. 320 km^2) includes archaeological and historical sites, business areas, and residential neighbourhoods.

The climate in Rome is typically Mediterranean, with mild winters and relatively hot summers. The annual mean temperature is 15.8°C and mean annual precipitation is 745.0 mm. Given its location, the climate is influenced by the land-sea interaction and sea breezes are frequent. The scirocco, a southern wind, sometimes brings heat waves during the summer.

Air pollution in Rome originates primarily from motor vehicle traffic and home heating devices, while the contribution of industrial plants is negligible. As a result, concentrations of gaseous pollutants and airborne particles are generally high, but with different seasonal patterns.

The results of former APHEIS reports show that PM_{10} levels in Rome are higher than in most other European cities. Consequently, the potential benefit of reducing PM_{10} levels assessed in terms of avoidable cases of mortality and hospital admissions was bigger than in many other European cities (APHEIS 2nd and 3rd year reports).

For the present report HIA was performed on the health and air pollution data for the year 2001 for two reasons: firstly, because the year 2001 was chosen as the latest common year available for all APHEIS cities, and secondly, because hospital admission data were not available for more recnt years at the time HIA was performed. The impact of PM10 and Ozone on the health of the entire city population (mortality and hospital admissions) was evaluated with a special focus on respiratory causes in children (postneonatal mortality and hospital admissions of children under 15 years of age).

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

Air pollution in Rome originates primarily from motor vehicle traffic and home heating devices, while the contribution of industrial plants is negligible. As a result, concentrations of gaseous pollutants and airborne particles are generally high, but with different seasonal patterns.

With regard to PM10, more than 60% are estimated to be attributable to traffic and about 30% to home heating devices in the city of Rome.

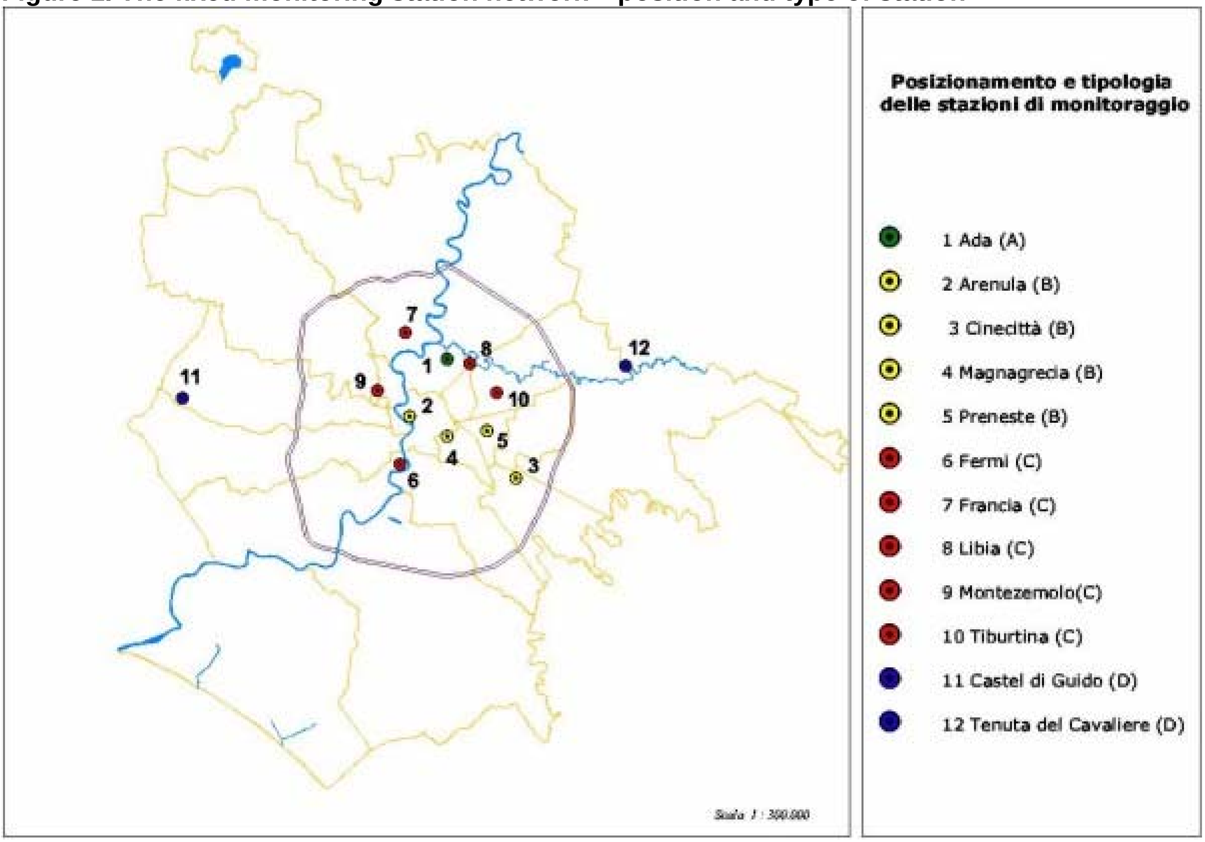
In recent years there has been a trend of decreasing levels of all pollutants, except O_3 that was increasing. Between 1993 and 1996 annual mean levels of TPS decreased from 90 $\mu g/m^3$ to 72 $\mu g/m^3$. Since 1998, PM10 has been

measured and the annual mean levels were 45.5µg/m^3, 51.5µg/m^3, 47.2µg/m^3, and 48.12µg/m^3 in 1999, 2000, 2001, and 2002 respectively.
Regulatory measures have been implemented concerning the fixed PM10 sources (heating and industrial plants). Thus, the relative contribution of traffic to the overall pollution has increased, and recent initiatives therefore have focused on traffic borne pollution.
It is important to note the contribution of natural sources to particulate matter, such as the dust carried into the city by southern winds, which cannot be abated.

Exposure data

Among the 12 fixed monitoring stations in the city of Rome, only two measured PM_{10} in 2001, namely Magna Grecia (4) and Fermi (6). $PM_{2.5}$ was not measured. Ozone measurements refer to the stations Preneste (5) and Villa Ada (1) (Figure 1).

Figure 1. The fixed monitoring station network – position and type of station



PM_{10} is measured using an automated β-gauge method. Compared to gravimetric methods, the automated method underestimates the PM concentration. Therefore, for the long-term health impact assessment, which uses relative risks based on gravimetric methods, a correction factor of 1.3 was applied to the original data (according to the recommendations by the EC working group on particulate matter with respect to EC directive 1999/30/EC).
Ozone measurements occur through ultra-violet ray absorption.

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 has been calculated for the entire year 2001, whereas the daily maximum 8-hour moving averages of each day have been calculated for the summer period (1st April to 30th September).

The annual mean level (SD) of PM10 (corrected by 1.3) in Rome was 61 (22) µg/m^3, and P5 and P95 of the daily mean values were, respectively, 32 µg/m^3 and 100 µg/m^3. The mean (SD), P5 and P95 of the daily maximum 8-hour moving average concentrations of O_3 were, respectively, 105 (28), 58 and 156 µg/ m^3, and those of the daily maximum 1-hour concentrations 91 (44), 24 and 170 µg/m3 (Table 1 and figures 2-4).

Table 1. Descriptive statistics for ozone and PM_{10}* levels in Rome in 2001

** corrected by European default factor 1.3*

	O3 8h - summer	O3 1h max - year	PM10 - year
Number	183	365	365
Minimum	24	8	0
Percentile 5	58	24	32
Percentile 25	88	59	47
Median	103	89	60
Percentile 75	124	118	72
Percentile 95	156	170	100
Percentile 98	163	194	116
Maximum	188	222	172
Daily mean	105	91	61
standard error	28	44	22
% missing values	0.00%	0.00%	0.00%

Figures 2 and 3 show that in 2001, Ozone levels were quite variable over the year with two peaks around 60-70 µg/m^3 and 90-100 µg/m^3. Summer concentrations were higher, as expected with the highest number of days in the range 100-110 µg/m^3. Figure 4 shows that for PM10 most days are in the range between 30 and 90 µg/m^3.

Figure 2. Distribution of daily O_3 8h max in Rome in summer 2001

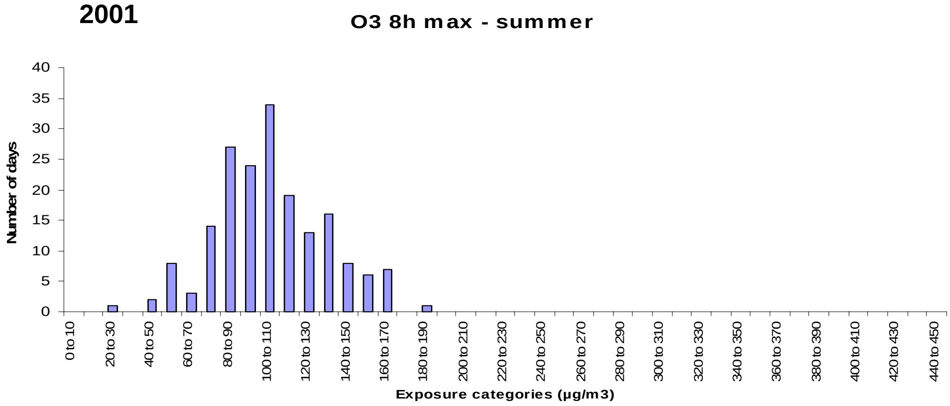


Figure 3. Distribution of daily O_3 1h max in Rome in 2001

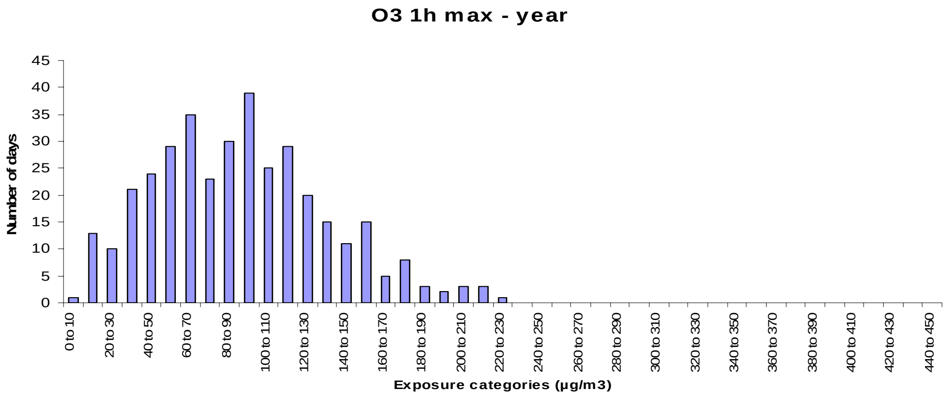
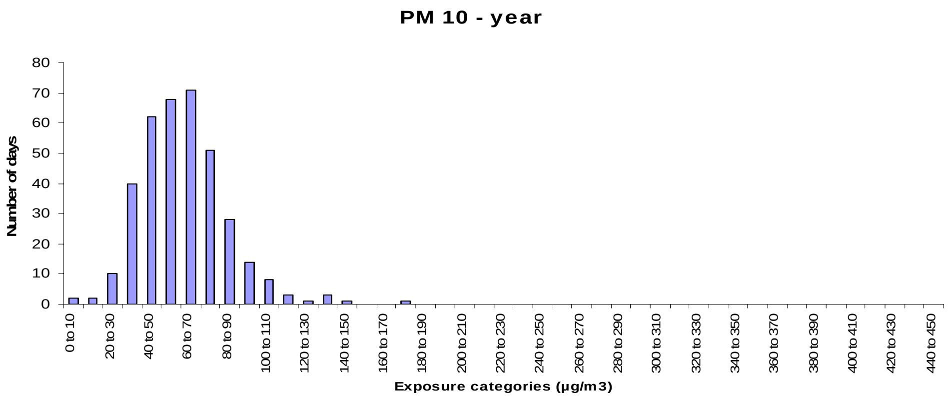


Figure 4. Distribution of daily PM10* in Rome in 2001
**** corrected by 1.3 correction factor***



Health data

Data on mortality were provided by the Mortality Information System of Rome (SIM). Individual information on sex, age, census tract of residence, date of death, place of death, and cause of death are available. This registry uses ICD-IX manual coding and is quality controlled. The percentage of missing data in main causes of death is less than 0.1. The incidence rate was calculated, excluding deaths occurring outside the municipality of Rome, and those of non-residents. The age-standardised mortality rate for Rome for the year 2001, using the European population[1] as a reference, was 661 per 100.000 inhabitants.

Data on hospital admissions were retrieved from the Regional Hospital Admission Information System, which uses ICD-IX coding and is quality controlled. 96% of both public and private hospitals in the Lazio region are included, and less than 0.1 % of cause admission data are missing. For HIA only primary diagnoses defined at discharge from the hospital were considered. The system does not permit a classification of emergency admissions. Incidence data for cough and lower respiratory symptoms (LRS) are not available in Rome, either. Therefore, HIA for cough, LRS and emergency room visits for asthma could not be performed.

Health outcomes analysed for your HIA are shown in Table 2: numbers for postneonatal mortality are low and, as a consequence, estimates for sudden infant death syndrome are not available.

Table 2. **Descriptive statistics for health outcomes in Rome in 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			20	92.4	-	-	-
Respiratory *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99	1	4.6	-	-	-
Sudden infant death syndrome *ICD9 798.0 – ICD10 R95*	798.0	R95	0	0	-	-	-
GENERAL POPULATION MORTALITY							
Total mortality all causes *ICD9 <800 ICD10 A00-R99*	<800	A00-R99	20709	813.1	56.7 (9.5)	2.2	-
Cardiovascular mortality *ICD9 390-459 ICD10 I00-I99*	390-459	I00-I99	8503	333.9	23.3 (5.7)	0.9	-
Respiratory mortality *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99	1120	43.98	3.1 (1.9)	0.1	-
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			not available		
Hospital respiratory admissions - Age < 15 years *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99	4437	-	12.2 (5.6)	3.72	1356.8
Hospital respiratory admissions - Age 15 -64 years	460-519	J00-J99	4659	-	12.8 (4.7)	0.74	268.6
Hospital respiratory admissions - Age > 64 years	460-519	J00-J99	8192	-	22.4 (7.4)	4.63	1689.4

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)
	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. 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.

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 assesement 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) ***(not considered in Rome, because health data are not available)***

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 μg/m^3 was 3.53 (95%CI: 1.55-5.75), which is equivalent to an annual rate of 16.31 deaths per 100 000 (95%CI: 7.18-26.58).

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	0.46 (0.21-0.72)	2.14 (0.99-3.32)
	to 20 μg/m^3	3.53 (1.55-5.75)	16.31 (7.18-26.58)
	to 40 μg/m^3	1.91 (0.86-3.03)	8.83 (3.99-14.01)
Respiratory	by 5 μg/m^3	0.09 (0.05-0.14)	0.43 (0.21-0.66)
	to 20 μg/m^3	0.56 (0.22-1.06)	2.56 (1.02-4.90)
	to 40 μg/m^3	0.34 (0.15-0.58)	1.58 (0.70-2.67)
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	not available	not available
	to 50 μg/m^3	not available	not available
LRS <18 y	by 5 μg/m^3	not available	not available
	to 20 μg/m^3	not available	not available
	to 50 μg/m^3	not available	not available
Hospital respiratory admissions <15 y	by 5 μg/m^3	20.92 (-4.20-43.82)	6.40 (-1.28-13.40)
	to 20 μg/m^3	180.84 (-35.25-388.92)	55.30 (-10.78-118.93)
	to 50 μg/m^3	65.71 (-12.93-140.08)	20.10 (-3.95-42.84)

Regarding short-term effects of O_3 in summer, each reduction by 10 µg/m^3 of daily maximum 8-hour moving average concentrations would delay 31.25 (95%CI: 17.14-52.42) deaths per year in the study area, 18.77 (95%CI: 8.98-29.79) from cardiovascular diseases, and 5.70 (95%CI: 3.73-7.62) 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	by 10 µg/m^3	31.25 (17.14-52.42)	1.23 (0.67-2.06)
	to 120 µg/m^3	18.98 (10.39-31.90)	0.75 (0.41-1.25)
Cardiovascular	by 10 µg/m^3	18.77 (8.98-29.79)	0.74 (0.35-1.17)
	to 120 µg/m^3	11.61 (5.54-18.47)	0.46 (0.22-0.73)
Respiratory	by 10 µg/m^3	5.70 (3.73-7.62)	0.22 (0.15-0.30)
	to 120 µg/m^3	3.82 (2.49-5.13)	0.15 (0.10-0.20)
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	not available	not available
	Daily 8-h max		
Hospital respiratory admissions 15-64 y	by 10 µg/m^3	2.31 (-20.82-27.76)	0.13 (-1.20-1.60)
	to 120 µg/m^3	1.37 (-12.20-16.64)	0.08 (-0.70-0.96)
Hospital respiratory admissions > 64 y	by 10 µg/m^3	19.58 (-7.83-47.00)	4.04 (-1.62-9.69)
	to 120 µg/m^3	12.17 (-4.83-29.42)	2.51 (-1.00-6.07)

NA: Not applicable <u>if air pollution levels are lower than the scenario level</u>

Discussion

Assessment of exposure to air pollution in Rome in the year 2001 presented two limitations: firstly, PM10 and Ozone data were available from two monitoring stations only. Secondly, the fixed monitoring stations which were be included in this study showed different characteristics than the stations used in most other APHEIS cities, and were classified as traffic-related. Still it needs to be stressed, that the monitoring stations are placed in highly urbanised areas and therefore represent the air breathed by the major part of the city population.
Health indicators (mortality and morbidity) were readily available and are very reliable.

The findings of the APHEIS-3 report, using the same exposure data for PM10 (year 2001) for different scenarios, indicated that in Rome there is a considerable potential for health benefits in the adult population through the abatement of air pollution (see APHEIS-3 report).
These results were not confirmed in the present project assessing the potential impact on children:
The potential benefit of a reduction of ***PM10*** on ***postneonatal mortality*** is negligible, with numbers of attributable cases smaller than one per year for all scenarios except for reduction to 20 µg/m^3 (3.53 cases per year) and 40 µg/m^3 (1.91 cases per year).

The numbers of ***hospital admissions for respiratory causes in children below 15 years*** are higher, but not significant (e.g. reduction to 20 µg/m^3: 180.84 cases , 95%CI: -35.25 – 388.92).

Rome is among those cities with the lowest percentage of neonatal (0.85%) and childhood population (12.84%) (see table of demographic statistics in the summary report) and together with the fact that the included outcomes are rare events (see table for annual deaths and annual death rate per 100 000 for each health indicator in the 31 cities) this is reflected in the produced estimates.

The assessment of the potential effects of ***Ozone*** reductions give evidence for minor benefits in the ***adult and elderly population*** in Rome (Table 6). Ozone levels in Rome are higher than in almost all other APHEIS cities (see table Ozone daily 8-hours maximum summer levels in 30 cities), but still the numbers of attributable mortality cases are lower compared to the estimates of the potential benefit of PM10 reductions for the same outcomes (e.g. total mortality: reduction of PM10 by 5 µg/m^3 = 60 attributable cases (APHEIS-3 report), reduction of O_3 by 10 µg/m^3 = 31 attributable cases). For morbidity, no statistically significant results are observed.

One important difference between the results for PM10 and Ozone reductions is the fact that while PM10 levels in Rome are substantially higher than the limits fixed by the EC directive (40 µg/m^3, 20 µg/m^3), Ozone levels are closer to the limit level of 120 µg/m^3, which implicates smaller benefits. Furthermore, the exposure response functions for outcomes focusing on Ozone are smaller than for those investigating exposure to PM10.

In conclusion, the present HIA shows that abatement of air pollution levels in Rome is associated with potential health benefits, even if the contribution of the present results to the evidences obtained from previous HIA (APHEIS 2 and 3) is limited.

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