Effetti sanitari a breve e lungo termine conseguenti all'esposizione ad IPA nella popolazione residente a Roma

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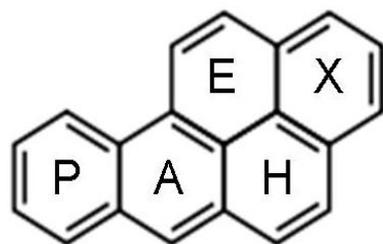
Roma, 11 giugno 2014

BACKGROUND

- **Strong evidence on the health effects of air pollution**, especially on cardiovascular and respiratory systems

- Long-term exposure to air pollution has been related to **cancer incidence**

- Last October, **IARC classified air pollution**, and in particular fine particles, **as carcinogenic to humans**

- Association between **long-term exposure to PAH** and health outcomes **less clear**

- **No evidence on the short-term health effects of PAH**

- To estimate population exposure to fine particles (**PM$_{2.5}$**), total polycyclic aromatic hydrocarbons (**PAHs**), and benzo[a]pyrene (**BaP**), and to investigate their association with mortality and morbidity in Rome, Italy, in terms of:

  ➢ **Short-term effects**

  ➢ **Long-term effects**

SHORT-TERM

DATA

PM$_{2.5}$:
- Daily exposure estimates at 1-km resolution ("case-base")
- Daily average exposure from ARPA monitoring stations in the city

PAHs and BaP:
- Daily exposure estimates at 1-km resolution ("case-base")
- Daily exposures estimates with data assimilation ("assimilated")

Other confounders: daily mean temperature, holidays, influenza epidemics, day of the week, long-term/seasonal time trends

ROME
June 2011 – May 2012

Mortality data: individual data with info on:
- Age and gender
- Cause of death
- Season (cold, warm)
- Place of death (home, in-hospital)

Hospitalization data: individual data with info on:
- Age and gender
- Primary discharge diagnosis
- Season (cold, warm)

METHODS

- **Case-crossover approach**: exposure on "case" day (day of death/admission) compared with average exposure on control days (same days of the weeks within the month)

- **Additional adjustment** for time-dependent confounders

- 3 lag intervals a priori defined to represent immediate, delayed or prolonged effects: **lag 0-1, lag 2-5 and lag 0-5**

- **Effect modification by age, gender, season, and place of death** (for mortality only)

- **Concentration-response function**

- All results expressed as **% increase of mortality/hospitalization relative to increments of pollutants equal to its interquartile range (IQR)**, on the distribution of differences between case-day exposure and control-days exposures
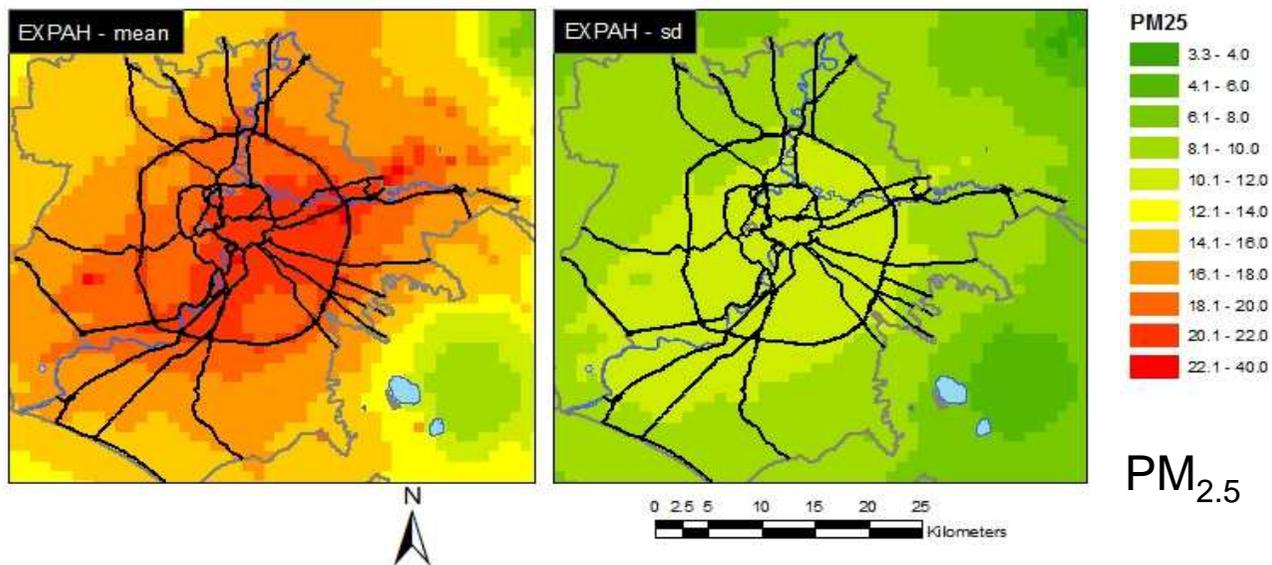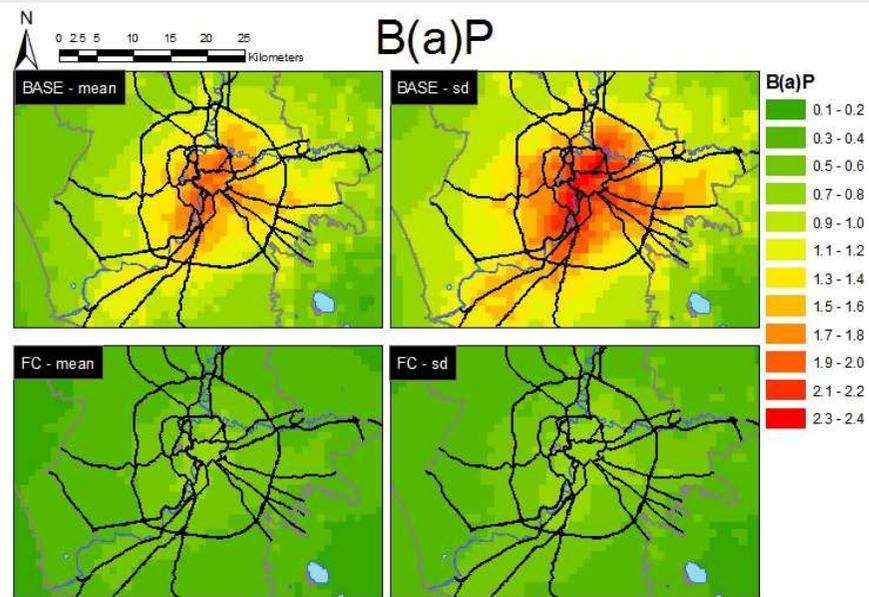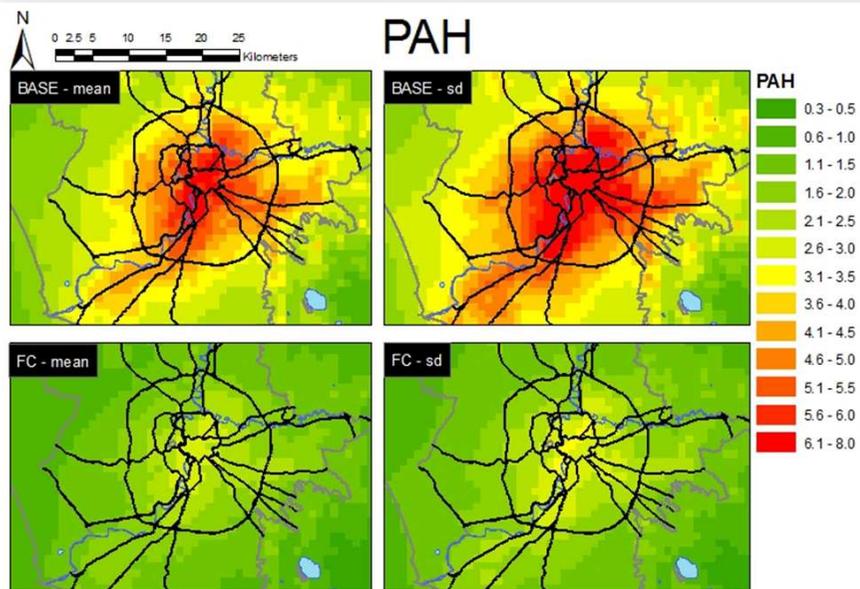
Variables	Mortality (N. 22,172)				Hospitalizations (N. 39,682)			
	Mean	SD	IQR		Mean	SD	IQR	
PAHs								
Base-case	5.47	6.23	8.08	**1.61**	5.35	6.14	7.76	**1.56**
Assimilated	2.38	2.56	3.55	**0.65**	2.32	2.51	3.35	**0.64**
BaP								
Base-case	1.62	1.90	2.48	**0.47**	1.59	1.87	2.38	**0.45**
Assimilated	0.59	0.64	0.89	**0.17**	0.57	0.63	0.84	**0.16**
PM$_{2.5}$								
Base-case	20.65	11.29	14.26	**13.08**	20.52	11.36	14.03	**13.23**
ARPA stations[1]	20.32	10.77	13.50	**14.00**	20.24	10.84	13.50	**14.00**
Air temperature	15.50	7.30	11.88	**5.57**	15.45	7.13	11.38	**5.50**

- **Higher values** (and more variability) **in "case-base"** as compared to "assimilated" series of PAHs and BaP

- Spatio-temporal **PM$_{2.5}$ series** ("case-base") has **similar distribution** to temporal-only series ("ARPA stations")

- **Very high correlations among all exposures,** whatever the estimation method

Variables		PAH base	PAH assimil.	BaP base	BaP assimil.	PM2.5 base	PM2.5 ARPA	Temp. Airport
PAH	Base-case	1.00						
PAH	Assimilated	0.95	1.00					
BaP	Base-case	1.00	0.95	1.00				
BaP	Assimilated	0.92	1.00	0.92	1.00			
PM2.5	Base-case	0.74	0.75	0.74	0.74	1.00		
PM2.5	ARPA stations	0.64	0.64	0.64	0.63	0.95	1.00	
Temperature	Airport monitor	-0.70	-0.71	-0.71	-0.72	-0.48	-0.37	1.00

RESULTS: Health data

Variables	No.	%
Deaths from natural causes	**22,172**	**100.0**
Causes of death (ICD-9 code)		
Cardiovascular	8,204	37.0
Cardiac	6,265	28.3
Cerebrovascular	1,628	7.3
Respiratory	1,508	6.8
Age (years)		
0-34	164	0.7
35-64	2,445	11.0
65-74	3,525	15.9
75-84	7,256	32.7
85+	8,782	39.6
Gender		
Men	10,489	47.3
Women	11,683	52.7
Season of death		
Cold (October-March)	12,104	54.6
Warm (April-September)	10,068	45.4
Place of death		
Home	7,556	34.1
In hospital	13,468	60.7
Other or missing	1,148	5.2

Variables	No.	%
Cardio-respiratory hospitalizations	**39,682**	**100.0**
Primary diagnosis (ICD-9 code)		
Cardiovascular	27,287	68.8
Ischemic heart disease	6,774	17.1
Heart failure	5,235	13.2
Cerebrovascular	6,430	16.2
Respiratory	12,395	31.2
COPD	816	2.1
Asthma	286	0.7

RESULTS: Effects on mortality

Mortality	Natural			Cardiac			Cerebrovascular			Respiratory		
	% IR	95% CI		% IR	95% CI		% IR	95% CI		% IR	95% CI	
PAH, base-case (IQR=1.61) (lag 2-5)	**2.39**	**0.45**	**4.37**	1.82	-1.51	5.27	-0.24	-6.88	6.88	2.99	-4.39	10.94
PAH, assimilated (IQR=0.65) (lag 2-5)	**2.03**	**0.47**	**3.60**	1.58	-1.09	4.32	-0.45	-5.77	5.18	2.76	-3.22	9.10
BaP, base-case (IQR=0.47)	**2.38**	**0.50**	**4.29**	1.88	-1.35	5.22	-0.08	-6.52	6.81	2.80	-4.36	10.51
BaP, assimilated (IQR=0.17)	**1.91**	**0.36**	**3.48**	1.69	-1.00	4.46	-0.53	-5.81	5.06	2.65	-3.31	8.97
PM2.5, base-case (IQR=13.08) (lag 0-5)	1.02	-3.60	5.87	-1.59	-9.50	7.00	4.45	-11.76	23.64	14.36	-5.25	38.02
PM2.5, ARPA (IQR=14.00) (lag 0-5)	1.52	-3.41	6.71	-0.84	-9.49	8.63	7.04	-10.78	28.41	14.98	-5.79	40.33

- Clear effects of all exposures on **natural and respiratory mortality**

- **No main differences between the methods** for exposure estimate

- **No association with hospital admissions**

RESULTS: Effect modification

Natural mortality and PAHs (lag 2-5)	Effects per 1.61 ng/m^3		
	% IR	95% CI	P $_{int}$
Overall	**2.39**	**0.45** **4.37**	**-**
Age			
0-64	3.39	-0.93 7.89	-
65-84	1.16	-1.24 3.62	0.345
85+	**3.55**	**0.98** **6.19**	0.946
Gender			
Males	2.14	-0.28 4.63	-
Females	**2.62**	**0.27** **5.02**	0.741
Season of death			
Cold (October-March)	**3.04**	**1.05** **5.07**	-
Warm (April-September)	**-16.50**	**-26.48** **-5.16**	0.001
Place of death			
Home	2.17	-0.53 4.93	-
In hospital	**2.71**	**0.46** **5.00**	0.722
Other or missing	-0.04	-6.58 6.96	0.542

- **Elderly display highest risks** of dying from PAH exposure

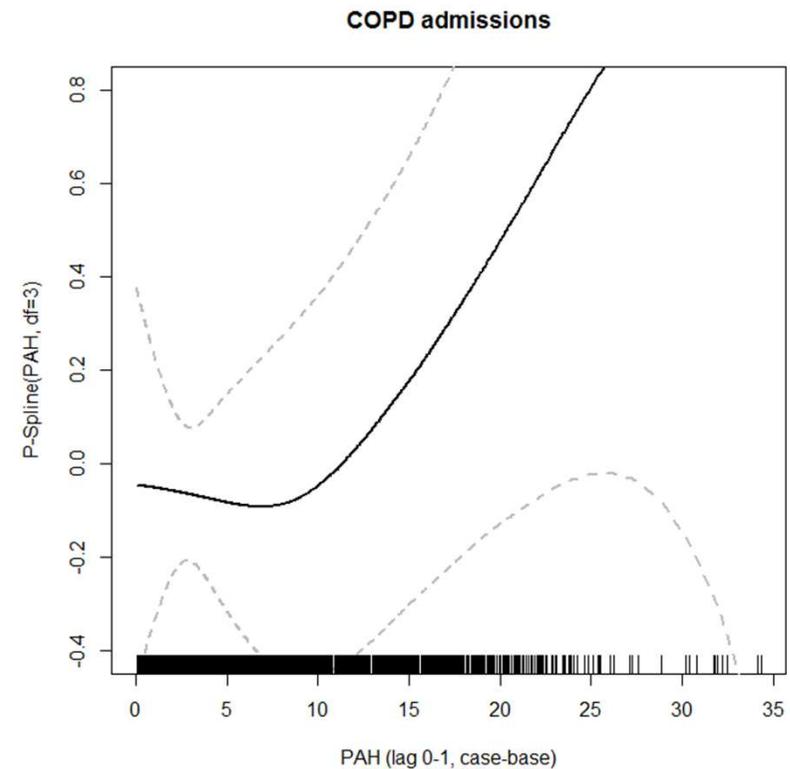- **No difference based on gender or place of death**; unclear results on season
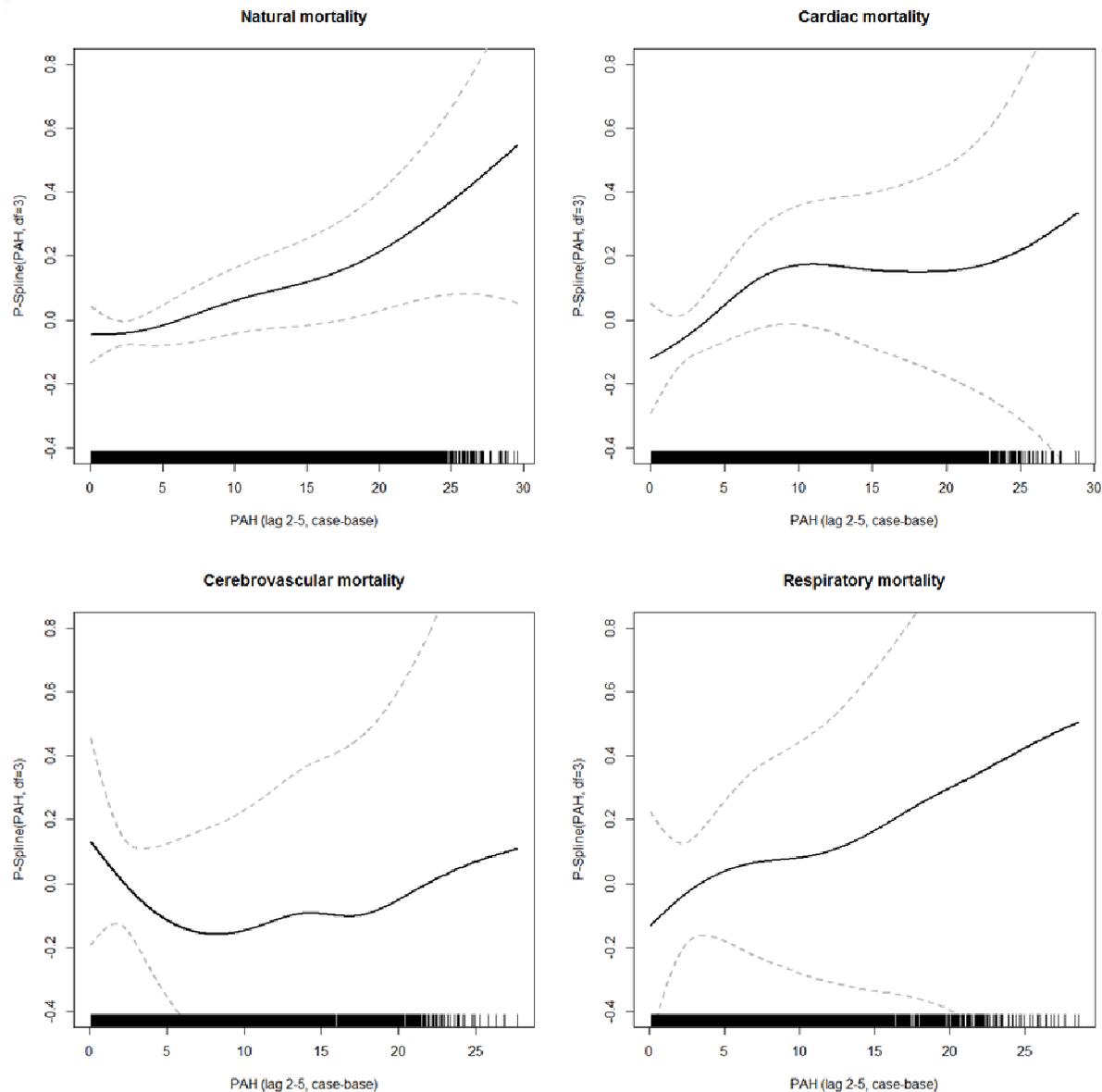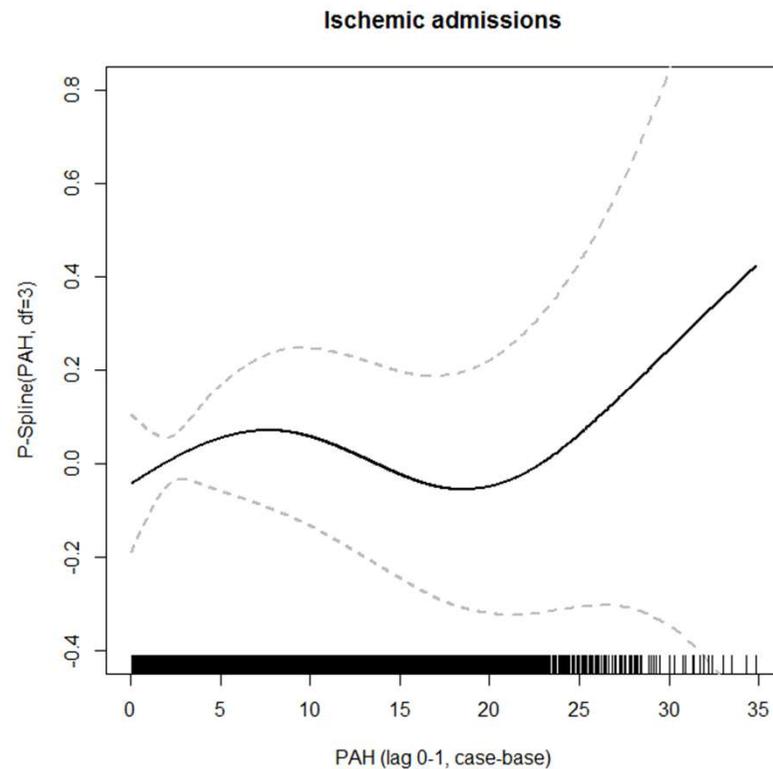
MORTALITY

- **Evidence of increasing linear association of PAH with natural and respiratory mortality**

- **Less clear shape for cardiovascular causes**

Ischemic admissions

COPD admissions

HOSPITALIZATIONS

- **Some evidence of increasing more-than-linear association with ischemic and COPD admissions, but with poor statistical power**
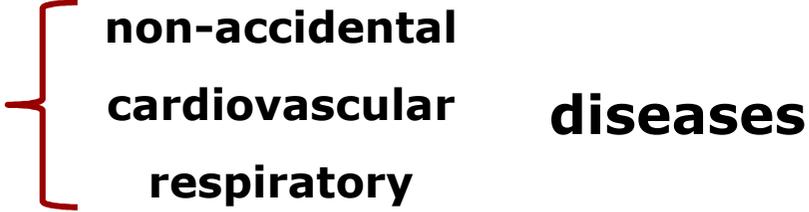
LONG-TERM

■ To estimate population exposure to fine particles (**PM$_{2.5}$**), total polycyclic aromatic hydrocarbons (**PAHs**), and benzo[a]pyrene (**BaP**), and to investigate their association with mortality and morbidity in Rome, Italy, in terms of:

➢ **Mortality** {
  non-accidental
  cardiovascular   **diseases**
  respiratory
}

➢ **Incidence of acute coronary events**

➢ **Incidence of stroke**

➢ **Incidence of lung cancer**

METHODS - The data

➢ The Rome Longitudinal Study (>2ml)

➢ Census based cohort

➢ Residents in Rome are followed from October 2001 to 2012

➢ Information on socio-demographic factors, contextual factors

➢ Vital status and residential history (Municipal Registry)

➢ Hospital discharges

➢ The study is part of the National Statistical Programme

METHODS

- Subjects who were living in Rome on the 1 January 2008

- Aged 40 years or more

- Exclusion of 0.06% subjects with non unique identifier in the information health system

- 1996-2007 prevalent cases of acute coronary event, stroke and malignant tumor (hospital discharges and exemption tickets)

- Incident cases 2008-2012

- Exposure at baseline address

METHODS

➢ Acute coronary events

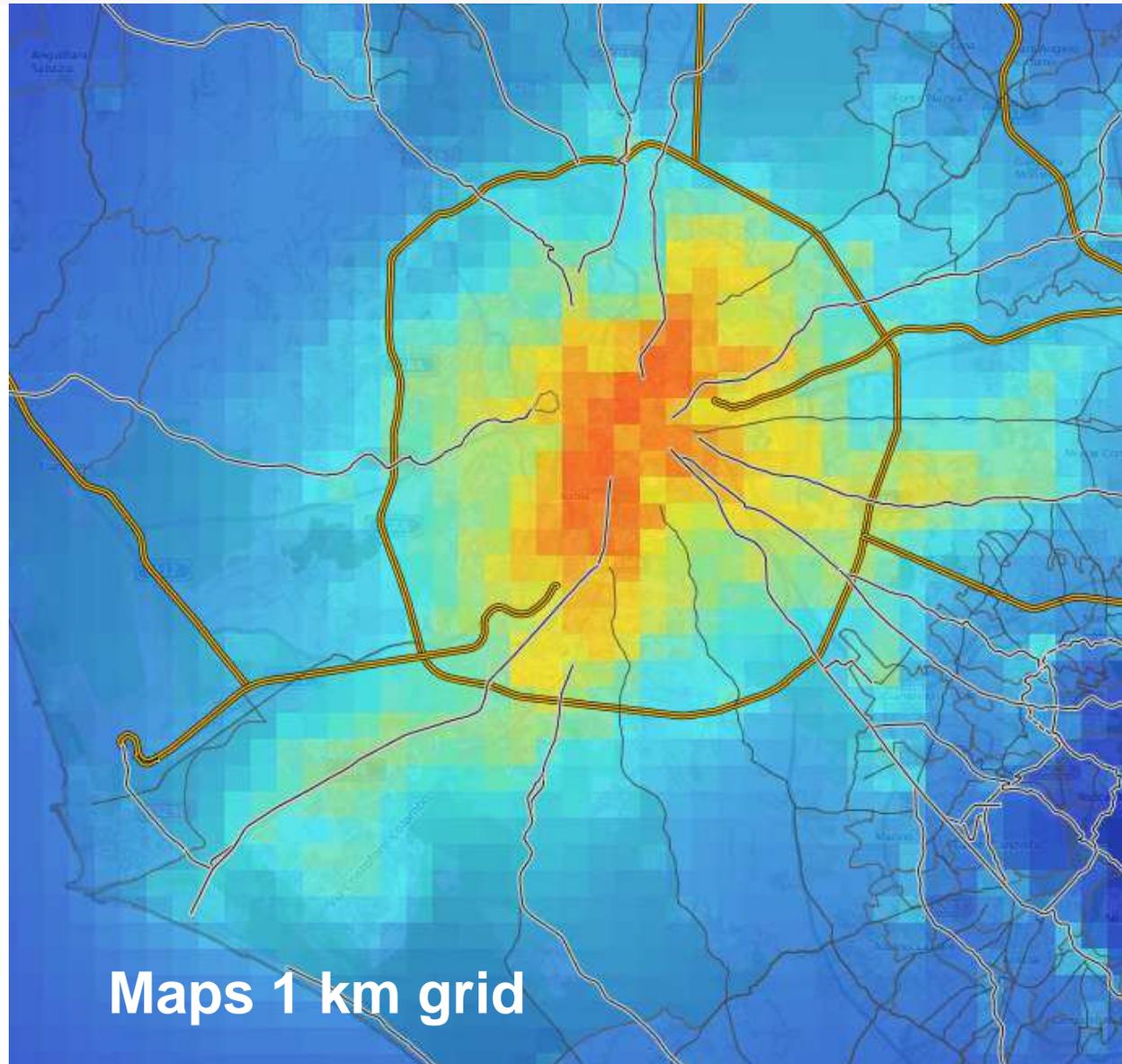   discharges ICD-9-CM: 410-411, mortality ICD-9: 410-414

➢ Stroke

   discharges ICD-9-CM:431,433.x1,434,436, mortality 431-436

➢ Lung cancer ICD-9 162

Cox proportional hazard models to evaluate the association between exposure and outcomes adjusting for individual and contextual factors.

Maps 1 km grid

Table 1. Descriptive statistics of environmental variables in Rome population

| Variables | No. Subjects | Mean | SD | Percentiles | | | | | | | IQR |
				min	5th	25th	50th	75th	95th	max	
PAH	1,013,886	2.15	0.39	0.52	1.40	1.91	2.23	2.43	2.70	2.76	0.52
BaP	1,013,886	0.53	0.10	0.13	0.35	0.47	0.55	0.60	0.67	0.68	0.13
PM2.5	1,013,886	19.94	1.48	13.37	16.69	19.23	20.32	21.07	21.57	22.84	1.84

Models based on measurements taken from 01/06/2011 to 31/05/2012

Table 2. Correlations between pollutants

	PAHs	BaP	PM2.5
PAHs	1.00		
BaP	1.00	1.00	
PM2.5	0.84	0.85	1.00

Table 3. Description of the study population and exposure

	N	PAHs (Mean, sd)		BaP (Mean, sd)		PM2.5 (Mean, sd)	
Gender							
Men	449,624	2.14	0.40	0.53	0.10	19.9	1.5
Women	564,262	2.16	0.39	0.53	0.10	20.0	1.5
Age class at baseline							
40-59	498,365	2.12	0.40	0.52	0.10	19.9	1.5
60-79	410,952	2.16	0.39	0.53	0.10	20.0	1.5
80-99	104,569	2.24	0.36	0.55	0.09	20.2	1.3

Table 3. Description of the study population and exposure

	N	PAHs (Mean, sd)		BaP (Mean, sd)		PM2.5 (Mean, sd)	
Level of education							
High	174,381	2.26	0.36	0.56	0.09	20.2	1.3
Medium	595,923	2.14	0.39	0.53	0.10	19.9	1.5
Low	243,582	2.10	0.40	0.52	0.10	19.9	1.6
Area-based socioeconomic position							
Very high	208,165	2.30	0.29	0.57	0.07	20.3	1.0
High	211,505	2.25	0.36	0.55	0.09	20.2	1.4
Medium	203,596	2.18	0.38	0.54	0.09	20.0	1.5
Low	200,068	2.03	0.43	0.50	0.11	19.7	1.7
Very low	189,783	1.98	0.40	0.49	0.10	19.5	1.6

	Non-accidental Mortality 80,941 deaths			Cardiovascular Mortality 32,460 deaths			Respiratory Mortality 5,282 deaths		
	HR	95%CI		HR	95%CI		HR	95%CI	
PAH (per 1.3 ng/m^3 increments)	1.05	1.02	1.07	1.06	1.02	1.10	1.05	0.95	1.16
BaP (per 0.3 ng/m^3 increments)	1.04	1.02	1.07	1.05	1.02	1.09	1.04	0.95	1.15
PM2.5 (per 5 ug/m^3 increments)	1.04	1.01	1.07	1.07	1.03	1.12	0.99	0.90	1.09

Hazard Ratios adjusted for: occupation, education, marital status, area-based SEP, income, diabetes, hypertension, stratified by sex, with age as time-scale

	HR	95%CI	
Incidence of lung cancer (7,585 cases)			
PAH (per 1.3 ng/m^3 increments)	1.10	1.01	1.19
BaP (per 0.3 ng/m^3 increments)	1.09	1.01	1.18
PM2.5 (per 5 ug/m^3 increments)	1.10	1.02	1.19
Incidence of acute coronary event (20,730 cases)			
PAH (per 1.3 ng/m^3 increments)	0.99	0.94	1.04
BaP (per 0.3 ng/m^3 increments)	0.99	0.94	1.03
PM2.5 (per 5 ug/m^3 increments)	0.99	0.94	1.04
Incidence of stroke (12,865 cases)			
PAH (per 1.3 ng/m^3 increments)	1.07	1.00	1.13
BaP (per 0.3 ng/m^3 increments)	1.06	1.00	1.12
PM2.5 (per 5 ug/m^3 increments)	1.10	1.04	1.18

Hazard Ratios adjusted for: occupation, education, marital status, area-based SEP, income, diabetes, hypertension, stratified by sex, with age as time-scale

CONCLUSIONS

short-term

➢ There is a clear association between exposure to air pollution and natural and respiratory mortality

➢ Highest effect in elderly with linear concentration response functions

➢ No evidence of association with cardio-respiratory hospitalizations

long-term

➢ There is a clear association between exposure to air pollution and natural and cardiovascular mortality

➢ There is a clear association between exposure to air pollution and incidence of lung cancer and incidence of stroke