**Dipartimento di Epidemiologia
del Servizio Sanitario Regionale
Regione Lazio**

The effects of particulate air pollution on hospital admissions for cardiac diseases in potentially sensitive subgroups. A multicity case-crossover analysis.

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Background

Several studies have shown that particulate air pollution (PM), generally measured as particles with aerodynamic diameter less than 10 micrometers (PM_{10}), is associated with increased risk of hospital admissions from cardiovascular causes.

Limited but growing evidence from recent epidemiologic studies suggests that persons with comorbilities, including diabetes, hypertension, congestive heart failure, recent myocardial infarction, and respiratory conditions, may be at increased risk of cardiovascular morbidity in relation to ambient air pollution levels.

Objective

The aims of the present study were:

□ **to estimate the short-term association between PM_{10} and daily cardiac hospital admissions in 9 Italian cities;**

□ **to identify subjects who are susceptible to PM_{10} due to their demographic characteristics or pre-existing medical conditions.**

Study population

The study population consists of all the hospitalizations of 65+ years old residents of 9 Italian cities (Bologna, Florence, Mestre, Milan, Palermo, Pisa, Rome, Taranto and Turin) discharged with a diagnosis of cardiac disease between 2001 and 2005.

A total of 167,895 hospitalizations of 65+ year olds with a diagnosis of cardiac diseases were considered.

Outcomes

We selected primary diagnoses of:

❑*Cardiac Diseases (CD)* (ICD-9 code 390-429);

❑*Acute Coronary Syndrome (ACS)* (ICD-9 code 410, 411);

❑*Arrhythmias and Conduction Disorders (ACD)* (ICD-9 code 426, 427);

❑*Heart Failure (HF)* (ICD-9 code 428).

Effect modifiers

For each hospitalized subject, we collected information on age, sex and hospital admissions in the preceding two-year period using a record linkage procedure with the Hospital Discharge Registry.

Diseases considered as susceptible conditions

- ✓ **Cancer (ICD-9: 140-208)**
- ✓ **Diabetes (ICD-9: 250)**
- ✓ **Valve disorders (ICD-9: 394.0-397.1, 424, 746.3-746.6, 093.2)**
- ✓ **Hypertension (ICD-9: 401-405)**
- ✓ **Myocardial infarction (ICD-9: 410, 412) and other cardiac ischemic diseases (ICD-9: 411, 413, 414)**
- ✓ **Diseases of pulmonary circulation (ICD-9: 415-417)**
- ✓ **Conduction disorders (ICD-9: 426) and Dysrhythmias (ICD-9: 427)**
- ✓ **Heart failure (ICD-9: 428)**
- ✓ **Cerebrovascular diseases (ICD-9: 430-438)**
- ✓ **Chronic pulmonary diseases (ICD-9: 490-505)**
- ✓ **Cirrhosis and other chronic liver diseases (ICD-9: 571, 572)**
- ✓ **Renal failure (ICD-9: 584-588)**

Methods

- **STEP 1: city-specific analysis of the association between PM_{10} and daily cardiac hospital admissions.**

- **STEP 2: city-specific analysis of the effect modification by individual characteristics and medical history.**

- **STEP 3: meta-analysis of the overall effect and effect modification.**

Methods - STEP 1

A **"time-stratified" case-crossover design** was used to study the association between PM_{10} and hospitalization for cardiac diseases, and the effect modification by individual characteristics.

The confounding factors, controlled by conditional logistic regression analysis, were the population decrease during the summer period, holidays, influenza epidemics, barometric pressure and high and low temperature.

Methods - STEP 2

The potential effect modification of PM_{10} on the risk of hospitalization by demographic factors and medical history was assessed by means of **interaction**.
For each effect modifier, we added to the model an interaction term between PM_{10} and the effect modifier.
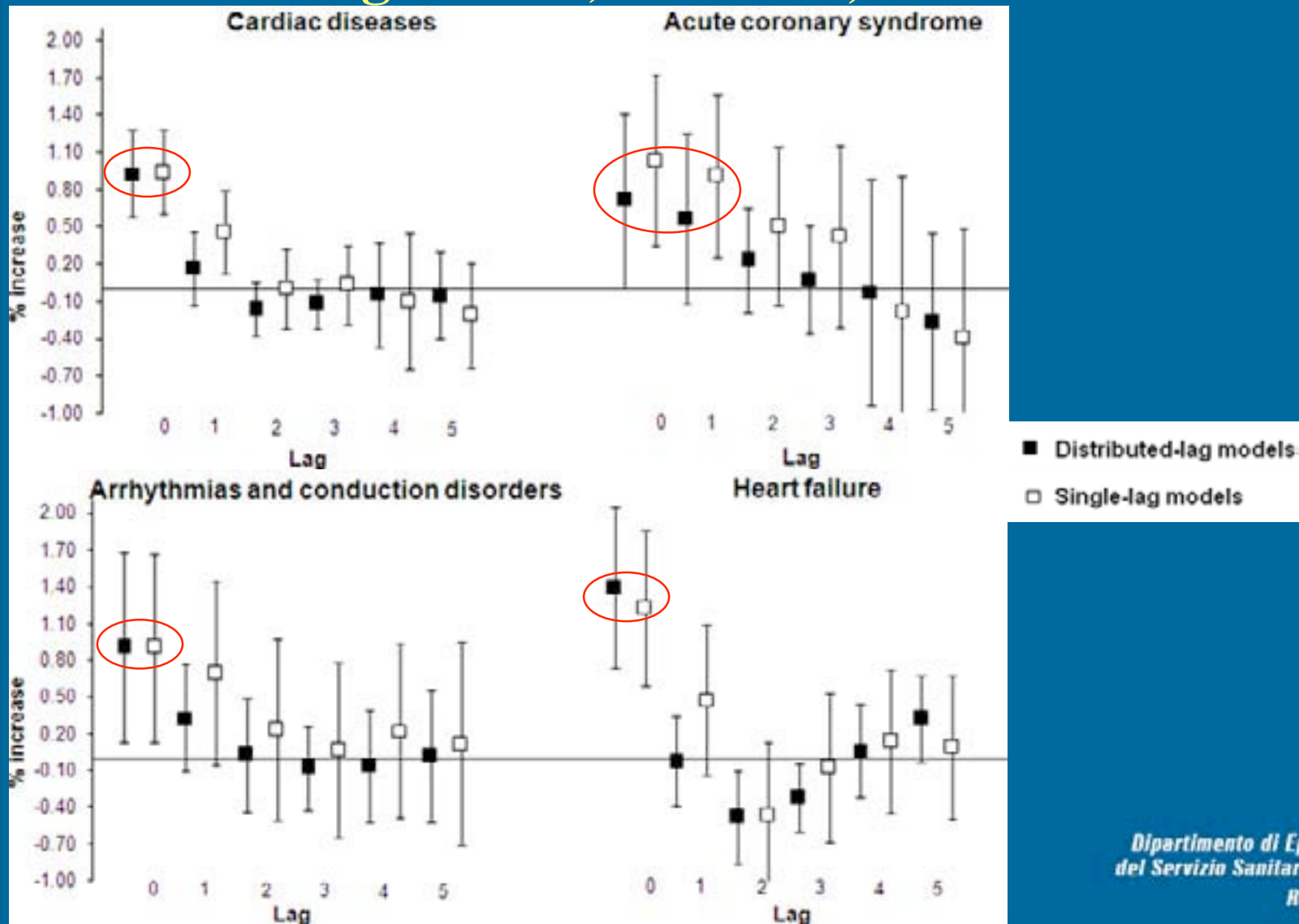
Methods – STEP 3

Finally a pooled estimate was obtained from city-specific results by applying a random-effects meta-analysis with the maximum likelihood method.

Results

Pooled results. Association between hospitalizations for cardiac diseases, by lag (from single-lag and constrained distributed lag models) – 9 cities, 2001 – 2005.

Pooled results. Association between hospitalizations CD and ACS and PM$_{10}$, by age and sex - 6§ cities, 2001 – 2005.

Variables	No.	Cardiac diseases (lag 0) % increase of risk	95% CI	p interaction	No.	Acute coronary syndrome (lag 0-1) % increase of risk	95% CI	p interaction
All	**156,117**	**1.03**	**0.69 ; 1.38**	**-**	**37,652**	**1.13**	**0.37 ; 1.89**	**-**
Age (years)								
65-74	55,777	0.75	0.21 ; 1.29	-	15,898	-0.14	-1.24 ; 0.97	-
75-84	67,856	1.27	0.78 ; 1.75	0.139	15,501	2.61	1.49 ; 3.75	0.000
85+	32,484	1.05	0.37 ; 1.73	0.426	6,253	0.83	-0.82 ; 2.52	0.340
Gender								
Men	77,042	0.77	0.30 ; 1.23	-	21,780	0.81	-0.15 ; 1.78	-
Women	79,075	1.29	0.84 ; 1.75	0.091	15,872	1.58	0.49 ; 2.68	0.229

§ Bologna, Florence, Milan, Palermo, Rome and Turin

Data are percent increases of risk, and 95% confidence intervals, relative to a 10 µg/m3 increase in PM10

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Pooled results. Association between hospitalizations ACD and HF and PM$_{10}$, by age and sex - 6§ cities, 2001 – 2005.

Variables	Arrhythmias and conduction disorders (lag 0)				Heart failure (lag 0)			
	No.	% increase of risk	95% CI	p interaction	No.	% increase of risk	95% CI	p interaction
All	**32,924**	**1.00**	**0.22 ; 1.78**	**-**	**42,358**	**1.37**	**0.74 ; 2.00**	**-**
Age (years)								
65-74	12,380	1.34	0.16 ; 2.52	-	10,548	1.58	0.40 ; 2.77	-
75-84	14,481	1.00	-0.10 ; 2.11	0.664	19,371	1.05	0.17 ; 1.95	0.456
85+	6,063	0.41	-1.23 ; 2.08	0.288	12,439	1.85	0.70 ; 3.01	0.767
Gender								
Men	15,140	1.89	0.80 ; 3.00	-	19,655	0.69	-0.18 ; 1.56	-
Women	17,784	0.29	-0.70 ; 1.28	0.020	22,703	1.99	1.17 ; 2.82	0.022

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Pooled results. Association between hospitalizations for CD and ACS and PM_{10}, by chronic conditions - 6[§] cities, 2001 – 2005.

Cardiac diseases (lag 0)					
Variables	No.	%	% increase of risk	95% CI	p interaction
All	156,117	100	1.03	0.69 ; 1.38	-
Arrhythmias and conduction disorders	27,420	17.6	1.56	0.80 ; 2.33	0.120

Acute coronary syndrome (lag 0-1)					
Variables	No.	%	% increase of risk	95% CI	p interaction
All	37,652	100	1.13	0.37 ; 1.89	-
Chronic pulmonary diseases	2,635	7.0	3.24	0.56 ; 5.99	0.123

[§] Bologna, Florence, Milan, Palermo, Rome and Turin

Data are percent increases of risk, and 95% confidence intervals, relative to a 10 µg/m3 increase in PM10

Pooled results. Association between hospitalizations for ACD and HF and PM$_{10}$, by chronic conditions - 6§ cities, 2001 – 2005.

Variables	Arrhythmias and conduction disorders (lag 0)				
	No.	%	% increase of risk	95% CI	p interaction
All	**32,924**	**100**	**1.00**	**0.22 ; 1.78**	**-**
Diseases of pulmonary circulation	287	0.9	7.06	-1.01 ; 15.78	0.128
Arrhythmias and conduction disorders	7,195	21.9	1.98	0.43 ; 3.54	0.124

Variables	Heart failure (lag 0)				
	No.	%	% increase of risk	95% CI	p interaction
All	**42,358**	**100**	**1.37**	**0.74 ; 2.00**	**-**
Hypertension	11,721	27.7	2.08	0.95 ; 3.23	0.126
Arrhythmias and conduction disorders	10,243	24.2	2.25	1.03 ; 3.48	0.117
Heart failure	11,889	28.1	2.01	0.90 ; 3.14	0.197
Cirrhosis and other chronic liver disease	941	2.2	4.46	0.10 ; 9.02	0.162

Conclusions

- We found that PM_{10} concentrations are associated with an immediate increased risk of hospital admissions for all cardiac diseases, acute coronary syndrome, arrhythmias and conduction disorders and heart failure.

- Women and subjects aged 75-84 years were more susceptible to the exposure of PM_{10} effects.

Conclusions

- We found that some individual characteristics modified the harmful effects of particulate matter:
  - ✓ a higher probability of acute coronary syndrome among chronic respiratory patients
  - ✓ a higher probability of heart failure among chronic hepatic diseases suffers.

- Previously diagnosed hypertension, arrhythmias and heart failure were suggested as possible effect modifiers.

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