

Air pollution and mortality in a cohort of patients with chronic obstructive pulmonary disease: a time series analysis

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Many studies have shown an association between current daily levels of air pollution and daily mortality by respiratory and cardiovascular causes in the general population.¹ However, the weak associations observed and the ecological nature of the exposure to air pollutants have created some doubts about plausibility of a causal relation. Specificity, which increases the plausibility of causal inference although its lack does not negate it, could be increased using a population more susceptible a priori.² Hence, we assessed the association between daily levels of air pollutants and daily mortality in a cohort of chronic obstructive pulmonary disease (COPD) patients in Barcelona for the years 1985 to 1989. We hypothesised that patients with COPD are more likely to die after increased exposure to urban air pollution than the general population.²

Methods

All patients attending emergency room services for either asthma or COPD were recruited during the years 1985 to 1989 in Barcelona. Vital status was obtained through record linkage of the people of the cohort with the Catalonia Mortality Registry for the years 1985 to 1989.³ A total of 9987 people (of the 15 517 in the initial cohort) had a diagnosis of COPD, 3245 of whom died in the period 1985 to 1989 and were used in this analysis. Cardiovascular mortality refers to codes 390 to 459 and respiratory mortality to codes 460 to 519 of the International Classification of Diseases (ICD-9).

Daily information on levels of black smoke, sulphur dioxide (SO₂), nitrogen dioxide (NO₂), ozone (O₃), temperature and relative humidity was collected from the city network.⁴

Poisson regression time series models were fitted for each pollutant (in a log-linear form)

and each different category of mortality following the APHEA methodology⁵ and adding the natural logarithm of the number of subjects at risk (that is, those still alive) as an offset. The analyses were done using Stata, release 5.0.

Results

The daily mean number of deaths was 1.8 for all causes mortality, ranging from 0 to 9, and 0.7 (0 to 5) and 0.5 (0 to 4) for respiratory and cardiovascular mortality, respectively. Levels of air pollutants have been published elsewhere.⁴

Table 1 shows the estimated association between air pollutants and mortality in our cohort compared with the estimates for the general population in Barcelona. Associations between one hour maximum of SO₂, 24 hours average of NO₂ and one hour maximum of NO₂, and mortality among COPD patients were stronger than associations obtained with the general population, mainly related to respiratory diseases.

Discussion

Daily mortality in COPD patients is related to daily levels of all six pollutants, for all, respiratory and cardiovascular causes. This association is stronger than in the general population only for peaks of SO₂ and daily means and peaks of NO₂. Particles, measured as black smoke, and daily mean of SO₂, the pollutants classically associated with mortality,⁶ showed similar or weaker associations for COPD patients than for the general population. Changes in the profile of urban air pollutants, with a currently more pronounced photochemical component, could explain in part these effects.

Caution is necessary when comparing with the general population given the small range of

Table 1 Estimated relative risks and 95% confidence limits for total, respiratory and cardiovascular mortality for an increase of 50 µg/m³ in air pollutants, in the general population and a cohort of COPD patients in Barcelona

	Black smoke 24 h	lag	SO ₂ 24 h	lag	SO ₂ 1 h	lag	NO ₂ 24 h	lag	NO ₂ 1 h	lag	O ₃ 1 h	lag
Total mortality												
general population*	1.056	0-3	1.078	0-3	1.013	1	1.043	0-3	1.017	1	1.024	5
	1.027, 1.087		1.041, 1.116		1.004, 1.021		1.011, 1.076		1.006, 1.027		1.006, 1.042	
COPD	1.023	0-2	1.045	0-2	1.036	2	1.145	0-2	1.023	2	1.040	3
	0.915, 1.145		0.914, 1.193		0.999, 1.074		1.006, 1.304		0.975, 1.115		0.953, 1.134	
Respiratory mortality												
general population*	1.051	0-3	1.062	0-1	1.017	0	1.043	0-1	1.013	0	1.035	5
	0.975, 1.134		0.989, 1.141		0.994, 1.039		0.970, 1.122		0.983, 1.044		0.981, 1.092	
COPD	1.071	0-2	1.041	0-2	1.050	2	1.161	0-2	1.084	2	1.057	3
	0.903, 1.271		0.849, 1.276		0.993, 1.110		0.944, 1.428		1.005, 1.169		0.921, 1.214	
Cardiovascular mortality												
general population*	1.059	0-3	1.091	0-3	1.016	1	1.031	0-3	1.019	1	1.029	1
	1.019, 1.101		1.040, 1.144		1.005, 1.028		0.988, 1.076		1.004, 1.034		1.004, 1.054	
COPD	0.908	0-2	1.035	0-2	1.067	3	1.056	0-2	1.032	3	1.011	3
	0.733, 1.124		0.808, 1.325		0.999, 1.140		0.827, 1.348		0.942, 1.130		0.858, 1.192	

*Partially published in reference 4.

daily deaths that led to wide confidence intervals. This also precluded an adequate fit using time series models, according to the analysis of residuals. Results did not change using generalised additive models (not shown).

Respiratory mortality showed stronger associations for COPD patients than for the general population for all pollutants excepting averages of SO₂, while cardiovascular mortality did so only for peaks of SO₂ and the two measures of NO₂. This suggests that the susceptibility of COPD patients to air pollution is mainly related to their respiratory condition.

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Conflicts of interest: none.

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