

Effect of short-term exposure to low levels of gaseous pollutants on chronic obstructive pulmonary disease hospitalizations

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Abstract

We examined the associations between gaseous pollutants and hospitalization for chronic obstructive pulmonary diseases (COPD) among elderly people living in Vancouver, British Columbia, Canada, a city in which ambient air pollution levels are relatively low. We regressed the logarithm of daily counts of acute COPD hospitalization during the 5-year period from 1994 to 1998 on the daily mean levels of each pollutant, after accounting for seasonal and subseasonal fluctuations, non-Poisson dispersion, and weather variables. Nitrogen dioxide and carbon monoxide were significantly associated with hospitalization for COPD, and the magnitude of effects was increased slightly with increasing days of exposure averaging, with the relative risk for a 7-day average being 1.11 (95%CI: 1.04, 1.20) and 1.08 (1.02, 1.13) for nitrogen dioxide and carbon monoxide, respectively. There was no significant association between either sulfur dioxide or ozone and COPD hospitalization. The combined relative risk for all four gaseous pollutants on COPD hospitalization was 1.21. The effects of gaseous pollutants on COPD hospitalization were not significant after adjustment for PM₁₀, although its inclusion did not have a marked effect on the point estimates for relative risks. Nitrogen dioxide has a significant impact on COPD hospitalization. Further studies are needed to separate the effects of single pollutants from the combined effects of the complex mixture of air pollutants in urban atmospheres.

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1. Introduction

Chronic obstructive pulmonary diseases (COPD) are a major cause of morbidity and mortality worldwide, and COPD continues to cause a heavy health and economic burden around the world. Deaths due to or associated with COPD have been increasing steadily in the United States over the past 20 years. Exposure to outdoor air pollution is a potential risk factor for development or exacerbation of COPD.

Air pollution has been recognized as a trigger for exacerbations of COPD for more than 50 years and has led to the development of air quality standards in many countries that have resulted in substantially decreased levels of air pollutants derived from the burning of fossil fuels (MacNee and Donaldson, 2000). However, this decrease in the levels of traditional air pollutants was accompanied by an increase in the levels of other pollutants, such as carbon monoxide (CO), ozone (O₃), and nitrogen dioxide (NO₂), that associated with increased motor vehicle traffic in urban areas (Macfarlane et al., 2000; Thurston and Ito, 1999).

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Few studies have examined the effects of air pollution on people with COPD. Most of them have reported an association between particulate air pollution and COPD (Wordley et al., 1997; Sunyer and Basagana, 2001). However, inconsistent results have been found with gaseous pollutants (Sunyer and Basagana, 2001; Anderson et al., 1997). An European time-series study has suggested that gaseous air pollutants are important determinants of acute hospitalization for respiratory conditions, being at least as important as particulate mass (Fusco et al., 2001). In this study, we employ time-series methods to explore associations between gaseous pollutants and COPD hospitalization among elderly people living in Vancouver, British Columbia (BC), Canada, a city where ambient air pollution levels are relatively low and with the lowest ozone level among 16 Canadian cities (Burnett et al., 1997a).

2. Materials and methods

2.1. Study area

Vancouver is Canada's third-largest city, with an area population of more than 2 million inhabitants. The city, with mild winters and warm summers, is warmed by Pacific Ocean currents and protected by a range of mountains. Vancouver is also the commercial and cultural heart of Canada's West Coast, and has relatively low air pollution levels (Burnett et al., 1997a). The approximately 1 million automobiles in the city are the main source of air pollution.

2.2. Study subjects

The present analysis was based on data from the BC Linked Health Dataset (BCLHD) (Chamberlayne et al., 1998). The BCLHD is housed at and has been developed by the Centre for Health Services and Policy Research at the University of British Columbia. The BCLHD contains data files from a number of different sources. Information about an individual's encounter with the BC health care system may occur as a Medical Services Plan record, a Hospital Separations record, a Pharmacare record, or an incidence of cancer reported to the BC Cancer Agency. The information from each data file in the BCLHD is linkable at the level of the individual. The Hospital Separations file was used in this analysis. Health outcomes were ascertained using primary discharge diagnosis records for residents of the study area between January 1, 1994, and December 31, 1998. Only those considered emergencies or urgent were selected, with an exclusion of planned admissions and transfers from other institutions. Study subjects were adults 65 years of age or older who had acute COPD [International Classification of Disease Codes, Ninth Revision

(ICD-9): 490–492, 494, and 496] admissions at hospitals in greater Vancouver, BC during the 5-year period from 1994 to 1998.

2.3. Air pollution and weather data

Gaseous [CO, NO₂, sulfur dioxide (SO₂), and O₃] and thoracic particulate matter (PM₁₀, <10 μm in average aerodynamic diameter) measurements were available on a daily basis throughout the study period. Daily measurements of gaseous air pollutants were available from 5 to 31 monitoring stations between 1994 and 1998. Specifically, daily average pollutant levels were available for carbon monoxide (6 stations), sulfur dioxide (5 stations), nitrogen dioxide (31 stations), and ozone (25 stations). Continuous sampling measures for air gaseous and particulate pollutants had been compiled for the 13 census subdivisions in the greater Vancouver area. Specifically, PM₁₀ levels were obtained using a tapered element oscillating microbalance. Only PM₁₀ was considered in multiple-pollutant models with gaseous pollutants because the relative risks of COPD hospitalization for PM_{2.5} (<2.5 μm in average aerodynamic diameter) and PM_{10–2.5} (average aerodynamic diameter between 2.5 and 10 μm) were lower than that for PM₁₀ in our recent study (Chen et al., 2004). In the study, Chen et al. conducted a time-series analysis among elderly people 65+ years of age living in Vancouver between June 1995 and March 1999 to assess the association between size-fractionated PM and hospitalization for COPD. Gaseous pollutants were measured daily using fixed-site ambient monitors operated by the Great Vancouver Regional District Air Quality Department (Vedal et al., 2003). CO, NO₂, SO₂, and O₃ were averaged with no missing average values. Average daily concentrations of these pollutants, results across monitors derived by taking a simple daily average for each monitor and then averaging these to obtain a final daily mean value, were used in all analyses. Daily average temperature (°C) and relative humidity were included to adjust for weather conditions. Other meteorological measures, including maximum temperature, minimum temperature, mean wind speed, and temperature change from the previous day, were also available but were not included in final models.

2.4. Statistical analysis

The association between air pollution and COPD was assessed using time-series analysis. Daily counts of COPD admissions were assumed to follow a time-homogeneous Poisson distribution. Quasilikelihood estimation, allowing for over- or underdispersion, was used to model the logarithm of daily counts of COPD admissions as functions of the predictor variables. Recently, Dominici et al. (2002) and Ramsay et al.

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