Science of the Total Environment 538 (2015) 478–491

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

The impact of communicating information about air pollution events on public health

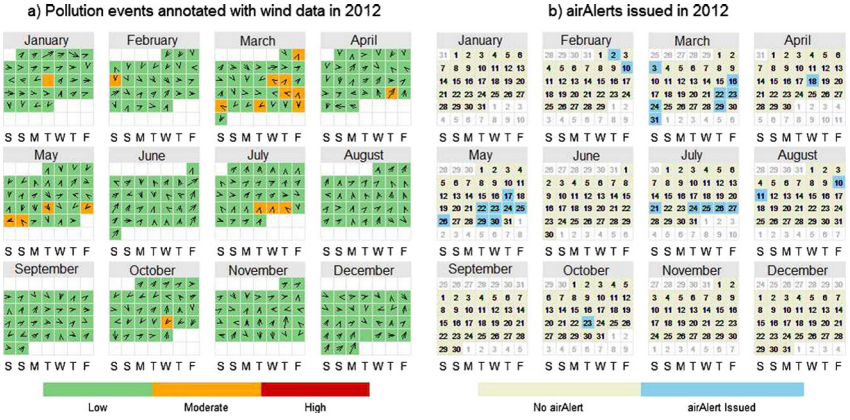
J. McLaren, I.D. Williams *

Centre for Environment Sciences, Faculty of Engineering and the Environment, University of Southampton, Lanchester Building, University Rd., Highfield, Southampton, Hampshire SO17 1BJ, UK

HIGHLIGHTS

- Investigation of relationship between hospital admissions and poor air quality
- Air quality forecasting service to reduce preventable hospital admissions evaluated
- Impacts of air quality on emergency admissions quantified using relative risks
- Pollution episodes cause admissions despite background concentrations in EU limits.
- Air quality forecasting service proved ineffective at reducing hospital admissions.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 12 May 2015
Received in revised form 22 July 2015
Accepted 30 July 2015
Available online xxxx

Editor: D. Barcelo

Keywords:
Air pollution
Pollution events
Respiratory health
Asthma
Nitrogen dioxide
Ozone
Particulates
Forecasting
Coastal city

ABSTRACT

Short-term exposure to air pollution has been associated with exacerbation of asthma and chronic obstructive pulmonary disease (COPD). This study investigated the relationship between emergency hospital admissions for asthma, COPD and episodes of poor air quality in an English city (Southampton) from 2008–2013. The city's council provides a forecasting service for poor air quality to individuals with respiratory disease to reduce preventable admissions to hospital and this has been evaluated. Trends in nitrogen dioxide, ozone and particulate matter concentrations were related to hospital admissions data using regression analysis. The impacts of air quality on emergency admissions were quantified using the relative risks associated with each pollutant. Seasonal and weekly trends were apparent for both air pollution and hospital admissions, although there was a weak relationship between the two. The air quality forecasting service proved ineffective at reducing hospital admissions. Improvements to the health forecasting service are necessary to protect the health of susceptible individuals, as there is likely to be an increasing need for such services in the future.

* Corresponding author.
E-mail address: idw@soton.ac.uk (I.D. Williams).

http://dx.doi.org/10.1016/j.scitotenv.2015.07.149
0048-9697/

1. Introduction

1.1. Background

Air pollution has recently been stated as 'Britain's forgotten health crisis' (CIWEM, 2013) and is becoming increasingly important for Local Authorities. Air pollution has serious short and long-term health and nuisance effects, particularly for susceptible individuals (Williams and McCrae, 1995; Brunekreef and Holgate, 2002; Bernstein et al., 2004; WHO, 2005) and causes 430,000 deaths per annum in UK urban areas (COMEAP, 1998).

A significant AQ-related adverse health impact is asthma, which is a chronic inflammatory disorder of the airways that causes recurrent coughing, wheezing, chest tightness and dyspnea (Balmes et al., 2003). There are 5.4 million people receiving treatment for asthma in the UK, equating to 1 household in every 5 feeling the effects of asthma (Asthma UK, 2014). Similarly, chronic obstructive pulmonary disease (COPD) is disease with significant extrapulmonary effects, characterised by progressive airflow limitation associated with an abnormal inflammatory response of the lung to noxious particles or gases (Rabe et al., 2007). Symptoms include increased breathlessness, persistent cough, frequent chest infections and wheezing. An estimated 3 million people suffer with the disease in the UK (NHS, 2012).

Both conditions can result in impaired quality of life, morbidity, and mortality (Jacobs et al., 2001; Ringbaek et al., 2005; Chung and Marwick, 2010). Air pollution can cause the exacerbation of both diseases (Kelly and Fussell, 2011), as well as variables such as temperature and influenza (Johnston et al., 1996; McAllister et al., 2013). Nevertheless a wealth of evidence exists to support the relationship between poor AQ and its effects on asthma and COPD in both the long and short-term (Table 1). The prevalence of both conditions has increased in recent decades (Welte and Groneberg, 2006). This poses implications for an already financially stretched health service, as COPD is the second most common cause for emergency hospital admission and is costly in

Table 1
A summary of the long and short-term effects of ambient air pollutants on asthma and COPD.

Author(s)	Main findings	Disease studied		Pollutants studied			
		Asthma	COPD	NO_2	O_3	PM_{10}	$PM_{2.5}$
Andersen et al. (2011)	Long-term exposure to traffic-related air pollution may contribute to the development of COPD with enhanced susceptibility in people with diabetes and asthma. Significant positive associations were found between all air pollution proxies and COPD incidence.	✓	✓	✓			
Atkinson (1999)	There is a 3% increase in hospital admissions for a 31 μg m^{-3} increase in PM_{10}. Significant associations were found between asthma visits and NO_2 and PM_{10}. No significant associations were found between respiratory complaints and O_3.	✓	✓	✓	✓	✓	
Beatty and Shimsack (2014)	There is a statistically significant increase in children's respiratory treatments with marginal increases of O_3.	✓	✓	✓	✓		✓
Delfino et al. (2002)	Pollutant associations with asthma symptoms were stronger in subjects not using anti-inflammatory medications. The strongest association between particulate concentrations and asthma symptoms was for a lag 0 1-hr max PM_{10} measurement. However more robust associations were shown for a 3-day moving average 8-hr max and 24-hr means for PM_{10}.	✓		✓	✓	✓	
Halonen et al. (2008)	There are positive associations for pooled asthma-COPD hospital visits in the elderly for $PM_{2.5}$, PM_{10} and NO_2 at short lags. $PM_{2.5}$ is associated with hospital admissions for asthma in children with a lag of up to 5 days.	✓	✓	✓		✓	✓
Hiltermann et al. (1999)	Ozone exposure produces a significant increase in the sputum levels of a number of inflammatory markers associated with the respiratory tract.	✓			✓		
Jacquemin et al. (2012).	There is a robust association between long-term exposure to O_3 and PM_{10} and uncontrolled asthma.	✓		✓	✓	✓	
Li et al. (2011)	There is evidence of significant increases in daily hospital admissions for asthma associated with $PM_{2.5}$.	✓		✓			✓
Meng et al. (2013)	An increase of 10 μg m^{-3} of 2-day moving average concentrations of PM_{10} and NO_2 corresponded to a 0.78% and 1.78% increase in COPD mortality, respectively.		✓	✓		✓	
Mortimer et al. (2002)	Each pollutant was associated with increased morning symptoms of asthma in children.	✓		✓	✓	✓	
Nadeau et al. (2010)	Increasing exposure to ambient air pollution is associated with impairment in T-cell function and increasing asthma morbidity.	✓			✓	✓	✓
Ostro et al. (1991)	$PM_{2.5}$ is significantly associated with increasing coughing symptoms in asthmatics. The level of outdoor exposure and exercise intensity strengthened the association between $PM_{2.5}$ and symptoms.	✓				✓	
Pope et al. (1991)	A concentration of PM_{10} of 150 μg m^{-3} is associated with approximately 3 to 6% decline in lung function. This association was observed on the current day and lagged day of pollution event. Elevated levels of PM_{10} pollution are also associated with increases in symptoms of respiratory disease and use of asthma medication.	✓				✓	
Qiu et al. (2012)	A 10 μg m^{-3} increment of a 3 day exposure lag was associated with and increase in COPD admissions by 1.76% and 3.43% for NO_2 and O_3 respectively, all of which were statistically significant. No consistent modifications of weather factors were found for PM_{10}. Generally it was found that gaseous pollutants increased COPD hospitalisations more in the cool season.		✓	✓	✓	✓	
Samoli et al. (2011).	An increase in concentration of 10 μg m^{-3} on the same day causes an increase in admissions by 2.54% and 1.10% for PM_{10} and NO_2 respectively. There is a reduction in admissions by 3.07% for O_3 over the year, however when this is reduced to the summer months, there is a 9.30% increase with 10 μg m^{-3} rise in O_3.	✓		✓	✓	✓	
Schwartz et al. (1993)	Daily emergency hospital admissions for people with asthma aged <65 were significantly associated with PM_{10} exposure on the previous day.	✓				✓	
Silkoff et al. (2005)	There are significant detrimental effects on lung function PM_{10} and NO_2 in the evening, which resulted in increasing medication use on the day of the pollution.		✓	✓		✓	✓
van der Zee et al. (2000)	Large decrements in morning peak expiratory flow in people aged between 50–70 are associated with PM_{10}.	✓		✓		✓	
Wordley et al. (1997)	10 μg m^{-3} increase in PM_{10} associated with 2.4% increase in hospital admissions and 1.1% in mortality.	✓	✓			✓	