Health effects of a sulphur dioxide air pollution episode

Terry P. Brown, Lesley Rushton, Moira A. Mugglestone and David F. Meechan

Abstract

Background A sulphur dioxide (SO₂) episode occurred in the United Kingdom in 1998. The worst affected area was the city of Nottingham.

Methods Emergency hospital admissions in Nottingham in the episode week were compared with those in the previous week.

Results A statistically significant increase in admissions for all respiratory diseases occurred in the episode week (odds ratio (OR) = 1.40, 95 per cent confidence interval (CI) = 1.00–1.94). Ten of the 25 excess admissions were for asthma, although the excess for asthma alone was not statistically significant (OR = 1.90, 95 per cent CI = 0.87–4.15).

Conclusions The excess admissions for respiratory diseases could have been caused by exposure to SO₂, to other pollutants present in increased concentrations during the pollution episode, or by seasonal variations in the frequency of asthma symptoms, or prevailing weather conditions. This study shows how simple analyses of routinely collected health data can be used to assess public health impacts of pollution episodes.

Keywords: air pollution episode, sulphur dioxide, respiratory disease, routinely collected health data

Introduction

On 2 September 1998, a sulphur dioxide (SO₂) air pollution episode occurred in the United Kingdom. The highest 15 minute mean concentration of SO₂ was 653 ppb; this was recorded in Nottingham, where the 15 minute mean standard of 100 ppb set by the Expert Panel on Air Quality Standards was exceeded 19 times. This paper describes an investigation into potential health effects of the episode. A major objective of the investigation was to determine whether simple analyses of routinely collected health data could be used to provide fast and efficient initial assessments of health effects associated with general pollution episodes.

Methods

Previous studies have shown that short-term changes in SO₂ concentrations are associated with increased emergency hospital admissions for respiratory diseases and deaths from all causes and respiratory and cardiovascular diseases. Our study was designed to detect similar effects. Although we examined data on admissions and deaths, we report results only for admissions as no statistically significant changes in deaths accompanied the SO₂ episode.

As health effects of SO₂ pollution are likely to peak shortly after exposure we compared emergency hospital admissions in Nottingham during the week beginning 2 September 1998 with admissions during the previous week. Corresponding data for 1995–1997 and 1999 were also examined. The county of Leicestershire, which was largely unaffected by the air pollution episode, was used as a control area. This form of analysis is similar to that used to investigate health effects of an earlier air pollution episode.

Anonymized data on emergency hospital admissions were obtained from Nottingham and Leicestershire Health Authorities for 24 August to 13 September in 1995–1999. These Health Authorities served resident populations of approximately 658,000 and 934,000, respectively. Eligible admissions were those for people admitted to hospitals within the Health Authority areas, regardless of their normal places of residence. Diagnoses were coded using the tenth revision of the International Classification of Diseases. We selected admissions with primary diagnoses corresponding to the standard diagnostic groupings: all causes except injury and poisoning (A–T); all respiratory diseases (J); lower respiratory tract infections (J10–J22); all obstructive lung diseases (J40–J47); chronic obstructive pulmonary disease...
(J40–J44, J47); asthma (J45, J46); all cardiovascular diseases (I); ischaemic heart disease (I20–I25); and acute myocardial infarction (I21).

The data were put into a standardized format and examined for potential errors. The data were supposed to relate to first consultant episodes (that is, time spent in the care of the first consultant to be assigned responsibility for the patient, regardless of whether responsibility was subsequently transferred to another consultant). We identified 2414 records in the data from Nottingham Health Authority that were duplicates of other records. The duplicates were excluded from subsequent analysis. The total number of admissions in Leicestershire in 1999 was much higher than in other years. Examination of the data by standard diagnostic groupings revealed that the number of admissions connected with the puerperium exceeded the average number of such admissions for 1995–1998 by 352. Leicestershire Health Authority was unable to account for the sudden increase. We decided to subtract 352 from the total number of admissions for all causes except injury and poisoning in Leicestershire in 1999 so that comparisons between years would be more meaningful.

The data were analysed using the statistical package SPSS. For each study area, year and diagnostic grouping, we calculated total numbers of admissions in the weeks beginning 26 August and 2 September, which we defined as control and episode weeks, respectively. For each area and diagnostic grouping relating to the episode year (1998), we estimated the odds of admission in each week by dividing the number of people admitted in that week by the number of people in the relevant population that were not admitted. The ratio of the odds of admission in the episode week to the odds of admission in the control week was then calculated. For each area and diagnostic grouping we pooled the data for the control years (1995–1997 and 1999) before calculating the corresponding total numbers of admissions in the weeks beginning 26 August and 2 September, which we defined as control and episode weeks, respectively. For each area and diagnostic grouping, we calculated a 95 per cent confidence interval (CI) for each odds ratio.

Results

Odds ratios comparing admissions in episode and control weeks in the episode and control years are shown in the Table. In both Nottingham and Leicestershire, the odds of admission for all causes except injury and poisoning were uniformly higher in the episode week than in the control week in both the episode and control years. The excess admissions in the episode week were statistically significant in Leicestershire (OR = 1.11, 95 per cent CI = 1.02–1.21 in the episode year; OR = 1.05, 95 per cent CI = 1.01–1.10 in the control years) but not in Nottingham.

In Nottingham, the odds of admission for all respiratory diseases were statistically significantly greater in the episode week than in the control week in the episode year (OR = 1.40, 95 per cent CI = 1.00–1.94) and non-significantly smaller in the control years. In Leicestershire, the odds of admission for all respiratory diseases were greater in the episode week than in the control week in both the episode year and the control years but neither increase was statistically significant.

In Nottingham, the odds of admission for lower respiratory tract infections, all obstructive lung diseases, asthma and chronic obstructive pulmonary disease were uniformly greater in the episode week than in the control week in the episode year, and uniformly smaller in the episode week than in the control week in the control years. None of the odds ratios was significantly different from one, although the number of admissions for asthma rose from 10 in the control week to 20 in the episode week (OR = 1.90, 95 per cent CI = 0.87–4.15), and five of the excess admissions were in the 0–14 years age group.

In Leicestershire, the odds of admission for lower respiratory tract infections, all obstructive lung diseases, asthma and chronic obstructive pulmonary disease were uniformly greater in the episode week than in the control week in the episode year but not significantly so. The odds of admission for lower respiratory tract infections and chronic obstructive pulmonary disease were smaller in the episode week than in the control week in the control years. However, the odds of admission for all obstructive lung diseases and asthma were greater in the episode week than in the control week in both the episode and control years.

<table>
<thead>
<tr>
<th>Diagnostic grouping</th>
<th>Nottingham Episode year</th>
<th>Control years</th>
<th>Leicestershire Episode year</th>
<th>Control years</th>
</tr>
</thead>
<tbody>
<tr>
<td>All causes except injury and poisoning</td>
<td>1.07 (0.97–1.18)</td>
<td>1.00 (0.96–1.05)</td>
<td>1.11 (1.02–1.21)</td>
<td>1.05 (1.01–1.10)</td>
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<tr>
<td>All respiratory diseases</td>
<td>1.40 (1.00–1.94)</td>
<td>0.85 (0.72–1.01)</td>
<td>1.29 (0.99–1.70)</td>
<td>1.05 (0.91–1.21)</td>
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<tr>
<td>Lower respiratory tract infections</td>
<td>1.19 (0.70–2.00)</td>
<td>0.80 (0.58–1.10)</td>
<td>1.41 (0.87–2.30)</td>
<td>0.89 (0.67–1.18)</td>
</tr>
<tr>
<td>All obstructive lung diseases</td>
<td>1.35 (0.80–2.26)</td>
<td>0.88 (0.68–1.33)</td>
<td>1.13 (0.73–1.74)</td>
<td>1.10 (0.88–1.37)</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>1.00 (0.49–2.03)</td>
<td>0.82 (0.58–1.16)</td>
<td>1.14 (0.63–2.08)</td>
<td>0.87 (0.63–1.20)</td>
</tr>
<tr>
<td>Asthma</td>
<td>1.90 (0.87–4.15)</td>
<td>0.97 (0.67–1.39)</td>
<td>1.11 (0.59–2.08)</td>
<td>1.39 (1.02–1.89)</td>
</tr>
<tr>
<td>All cardiovascular diseases</td>
<td>1.08 (0.84–1.38)</td>
<td>1.02 (0.90–1.16)</td>
<td>1.09 (0.87–1.37)</td>
<td>1.05 (0.93–1.18)</td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
<td>0.90 (0.59–1.36)</td>
<td>1.19 (0.97–1.46)</td>
<td>1.23 (0.83–1.81)</td>
<td>1.03 (0.84–1.25)</td>
</tr>
<tr>
<td>Acute myocardial infarction</td>
<td>0.67 (0.36–1.23)</td>
<td>1.08 (0.76–1.56)</td>
<td>1.22 (0.65–2.31)</td>
<td>1.16 (0.82–1.63)</td>
</tr>
</tbody>
</table>
than in the control week in the control years, the excess for asthma being statistically significant (OR = 1.39, 95 per cent CI = 1.02–1.89).

In both Nottingham and Leicestershire, the odds of admission for all cardiovascular diseases were uniformly higher in the episode week than in the control week but not significantly so.

Discussion

The tendency for all causes of admission to be higher in the episode week than in the control (previous) week appears to reflect an upward trend as autumn and winter approach. The small but statistically significant excess of admissions from all respiratory diseases in Nottingham in the week in which the air pollution episode occurred could be attributable to the effects of exposure to SO\(_2\) (or to other pollutants that were present in elevated concentrations during the episode, including particulates and nitrogen dioxide). Alternatively, the excess might be part of a seasonal trend, as (non-significant) excesses were observed in Leicestershire.

Admissions for asthma in the 0–14 years age group are generally low in August and they rise sharply in September.\(^5\)\(^5\)\(^5\) The September rise occurs around the time that children go back to school after their summer holidays, and respiratory infections increase at this time.\(^6\) In most of the study years, children in Nottingham went back to school towards the end of the episode week, and so this effect is unlikely to explain the excess asthma admissions observed in Nottingham in the episode week of the episode year. In Leicestershire, children were back at school at the end of the control week in each study year, and this could explain why the odds ratios in Leicestershire were greater than one in both the episode and control years.

Asthma symptoms are known to occur more frequently in periods of rainfall and low barometric pressure,\(^7\)\(^8\)\(^9\) but the effects of humidity are less clear.\(^7\)\(^9\) In Nottingham in the episode year, humidity and rainfall were higher and barometric pressure lower in the episode week than in the control week and this might explain some of the excess asthma admissions.

Although the increase in admissions for all respiratory diseases in Nottingham during the SO\(_2\) episode was small, our investigation has shown that it is feasible to use simple analyses of routinely collected health data to assess potential health impacts of a pollution episode. A similar approach could be used soon after any future pollution episode as an initial step in examining public health impacts. Any investigation based on emergency hospital admissions should incorporate checks on the quality of the data. Our experience suggests that data quality issues can be resolved by consulting personnel involved in collecting and disseminating hospital episode statistics. Primary care trusts are, therefore, well placed to assess public health impacts of future pollution episodes.

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References


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