# Air Pollution and Community Health

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Evidence relating to the effects of air pollution on health has recently been reviewed in a report to the Royal College of Physicians (1970) and the present paper is concerned mainly with the acute effects of periods of high pollution. The event that stimulated interest in this subject was the disastrous London fog of December 1952. In the official report on this episode (Ministry of Health, 1954) the excessive mortality and increased illness were attributed to contaminants of the fog, probably those from the combustion of coal, but it was not clear whether one particular pollutant could be indicted. Since then much experimental and epidemiological work has been done in our Unit and elsewhere to determine the relative importance of smoke, sulphur dioxide, and other associated pollutants in producing adverse reactions, but this problem is not yet solved. However, in the best public health tradition, corrective action has overtaken our research and, largely as a result of the Clean Air Act, 1956, much of the pollution from the burning of coal has been eliminated, at least in London.

The dramatic change in smoke concentrations in London during the past fifteen years is well illustrated by the results of our own measurements made at St Bartholomew's Hospital. We began our work there on the nature and effects of London fog in 1954, and in the first winter there was a great deal of smoke (solid line, Fig. 1) with many episodes of high pollution. We found that 'fogs' in London were mainly accumulations of smoke and other pollutants, and bronchitic patients were affected more by these than by true wet fogs (Waller and Lawther, 1955, 1957). The dotted line in Fig. 1 shows the results of our smoke measurements in a recent winter. Not only is the mean concentration very much lower than before: there are now very few sharp peaks, and the maximum concentrations are little higher than the minima of fifteen years ago.

We planned to take advantage of these long-term changes in pollution by carrying out a series of studies on the relationship between daily changes in the condition of bronchitic patients and pollution at intervals of five years, starting in 1959–60. With the co-operation of physicians at Chest Clinics in Greater London, about 1,000 patients whose symptoms of chronic bronchitis,

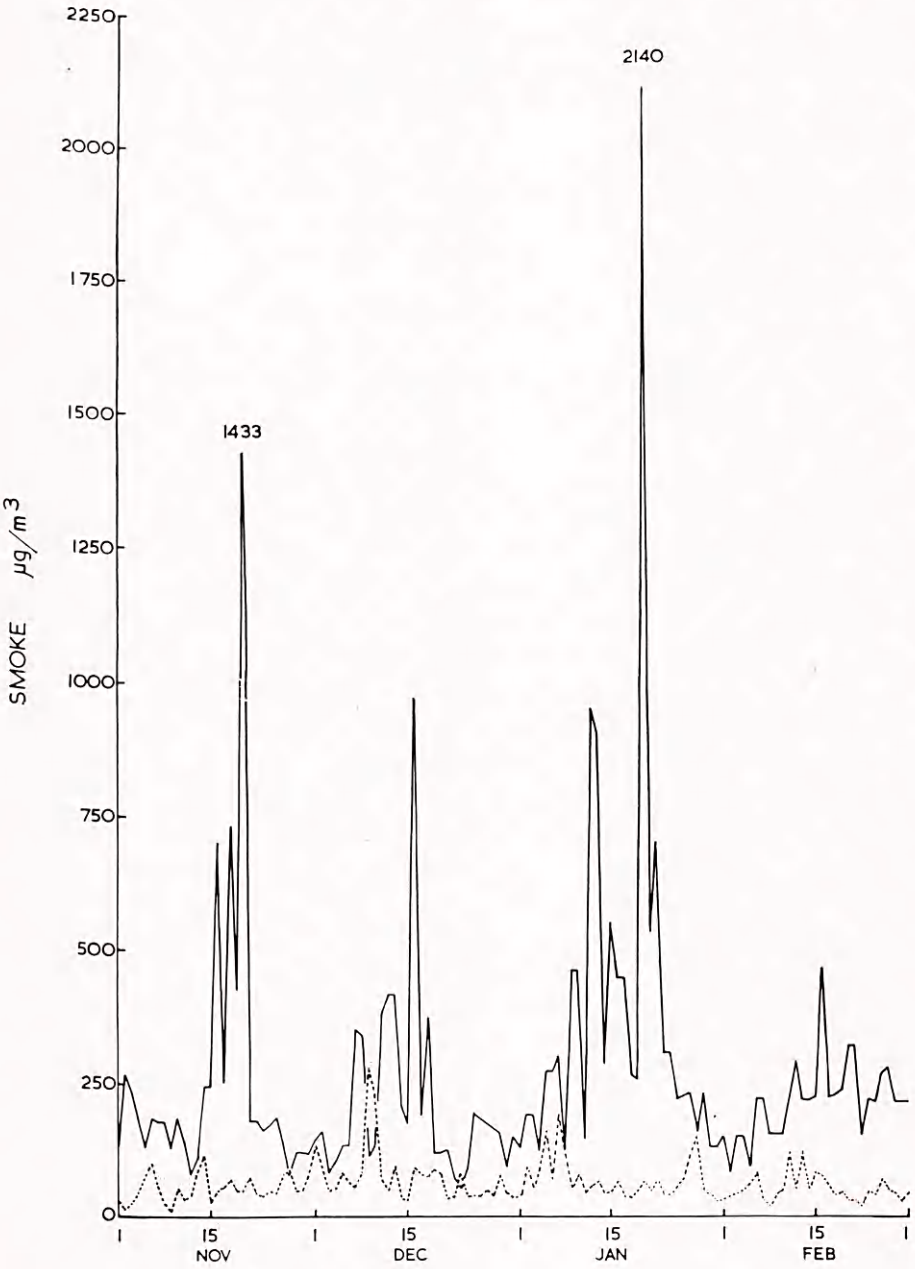


Fig. 1. Concentration of smoke as measured at St Bartholomew's Hospital, winter 1954–55 (——) and 1969–70 (– – –).

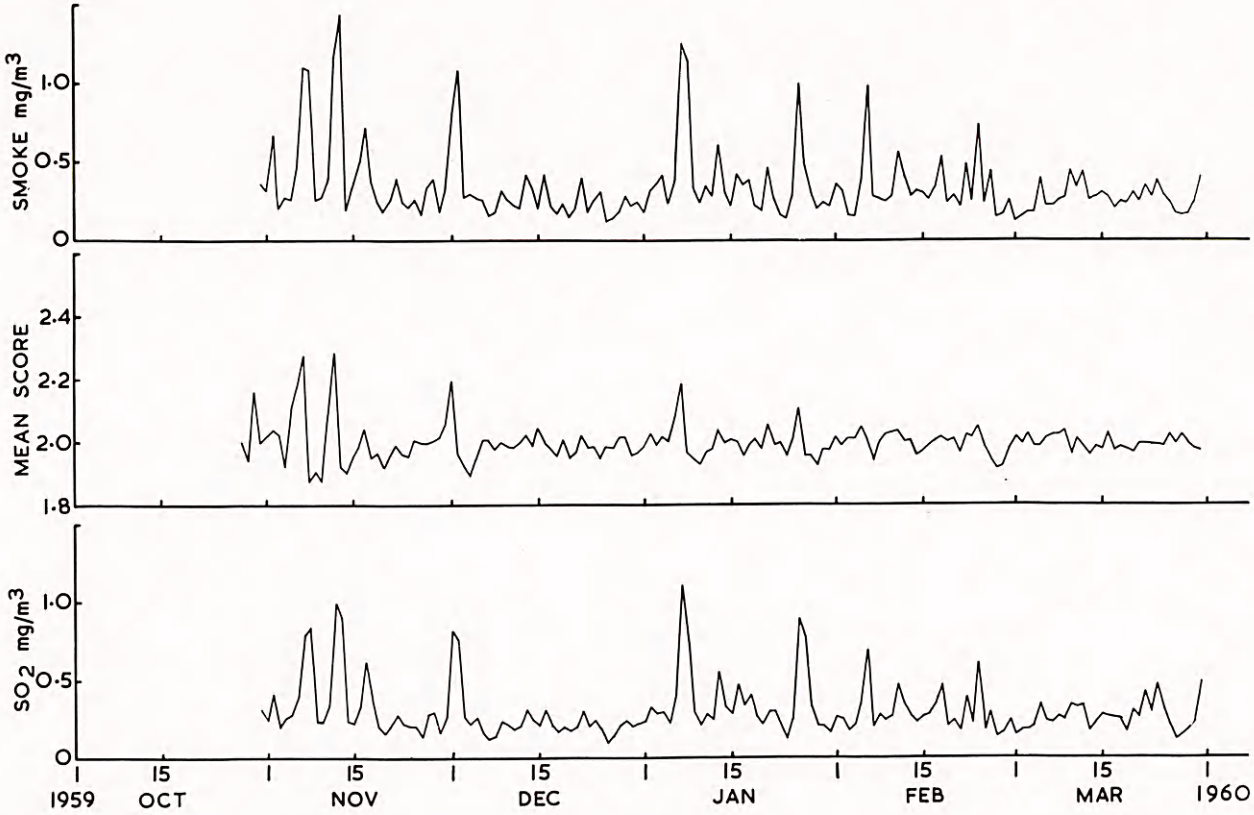


Fig. 2. Daily changes in the condition of bronchitic patients in relation to pollution, 1959–60.

emphysema or asthma were likely to be made worse by air pollution, were issued with small pocket diaries. They were asked to note what their breathing was like each day, and the following instructions were printed in the front of the diary:

Write BETTER if your condition has been better than the day before.
Write SAME if your condition has been the same as the day before.
Write WORSE if your condition has been worse than the day before.

This simple scheme worked well, even though a small proportion of patients tried to write long essays about each day's activities. Several different ways of assessing the results were tried, but the one that proved most satisfactory was a scoring system in which 'Better' was made equal to 1, 'Same' to 2, 'Worse' to 3, and the daily 'mean score' was calculated for all the patients.

The results from the first of these large-scale studies showed a very close relationship between mean score and the concentrations of smoke or sulphur dioxide (Fig. 2).

It is important to stress that the concentrations of smoke and sulphur dioxide are shown merely as indices of exposure to pollution. The measurements were made at seven sites in Inner London. We did not know the actual exposure of individual patients, nor did we know whether it was these pollutants or others associated with them that led to a deterioration in condition. We were able to conclude that when either of these indices of pollution exceeded a figure of about 1,000 $\mu g/m^3$ the patients became worse, and, at least at the beginning of the winter, when they appeared to be most sensitive, smaller amounts of pollution had some effect.

The next large study was in 1964–65. By that time smoke control was becoming effective in London and the mean concentration of this pollutant was only 38 per cent of that five years earlier. There had been a slight reduction in the mean concentration of sulphur dioxide also, and there were fewer days of high pollution when either of the indices exceeded 1,000 $\mu g/m^3$. There was, again, a general relationship between mean score and the indices of pollution, but the changes were smaller and less consistent than in 1959–60 (Lawther *et al.*, 1970).

Finally, a third study was done in 1969–70 when the average concentration of smoke was only one-fifth of that ten years earlier. The concentration of sulphur dioxide had declined too, to about two-thirds of its original value, and there were no days with the concentration of smoke or sulphur dioxide as high as 1,000 $\mu g/m^3$. In these more favourable conditions there were no sharp peaks in mean score (Fig. 3) and the small variations seen were related as closely to temperature as to pollution.

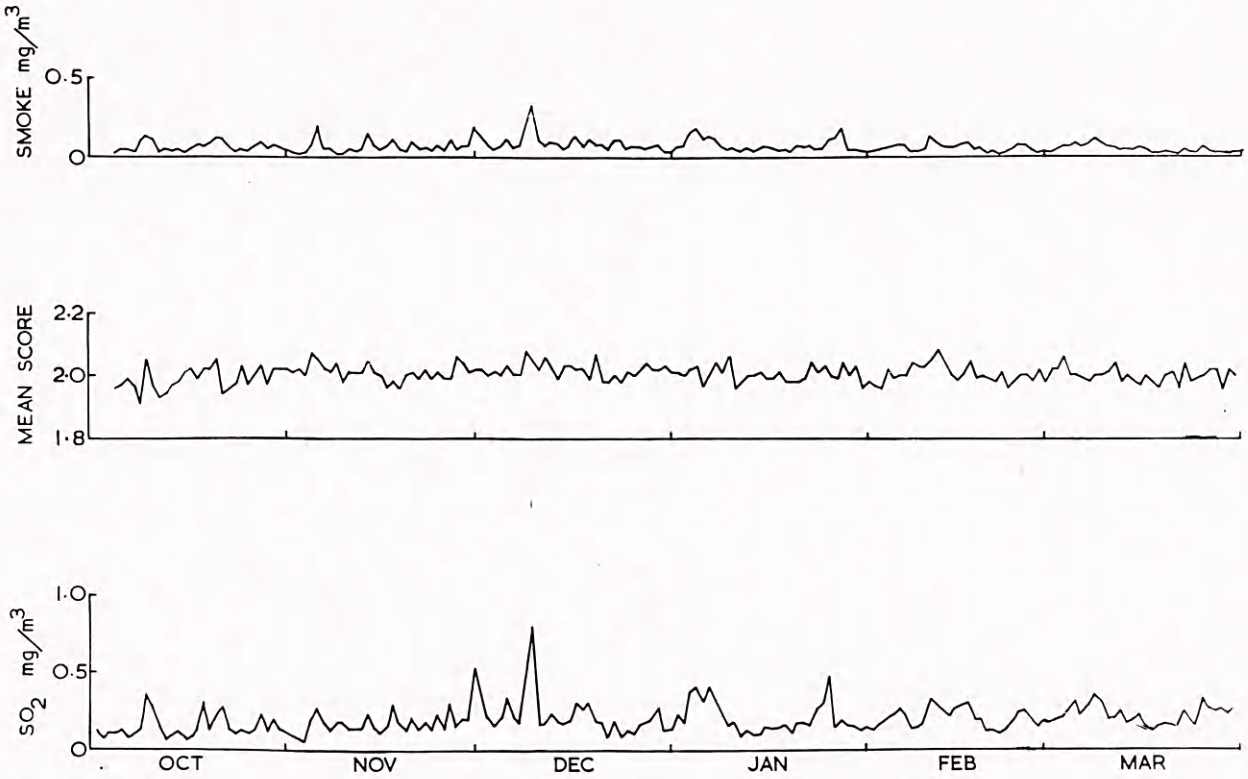


Fig. 3. Daily changes in the condition of bronchitic patients in relation to pollution, 1969–70.

These findings were encouraging, but they did not help us to solve the question as to which pollutant or combination of pollutants had been responsible for the effects observed previously. Not only was that winter entirely free from periods of high pollution by smoke, as anticipated, but perhaps as a bonus of smoke control, there had not been any occasions on which sulphur dioxide and other remaining pollutants accumulated to a serious extent. This situation has existed for several successive winters. It may be fortuitous that stable air conditions have not persisted for more than a few hours at a time during this period, but it is possible that the loss of the smoke 'blanket' over London has allowed the sun to break up temperature inversions more readily than before. The presence of an ever-increasing number of tall well-heated buildings in the central area also tends to increase turbulence.

The results displayed in Fig. 3 show that the condition of the patients varied much less from day to day than it did (among a different set of patients) ten years earlier. Many patients also commented that their general condition during the winter months was much improved now that the air of London was cleaner. There have, of course, been other changes that have helped bronchitic patients in recent years: in particular, the availability and effectiveness of therapeutic measures have improved, and we have never attempted to interfere with the treatments that patients were receiving.

Further evidence of the benefits of clean air has come from studies on variations in the daily death rate in London. There is always an increase in deaths during the winter months, but sometimes there are sharp peaks superimposed on this, and Martin and Bradley (1960) showed that daily deviations about a fifteen-day moving average were related to changes in the concentration of smoke or sulphur dioxide. It was also found that the number of patients seeking admission to hospital in London via the Emergency Bed Service showed a similar relationship to pollution (Martin, 1964). Most of the variation in daily deaths and hospital admissions was attributable to cardio-respiratory diseases, and these alone, or the total figures, can be related to pollution and other environmental factors. These mortality and morbidity indices have now been studied for more than ten successive winters: up to 1962–63 there were in each of them still sharp changes that could be related to pollution, and particularly in that winter when there were some 700 'excess' deaths at the time of the prolonged fog of December 1962. Since then, however, with a decreasing frequency of days of high pollution there has been little evidence of any effect of pollution and in recent winters there have been only random changes in mortality and morbidity (Waller *et al.*, 1969).

The studies reported here are all concerned with sudden changes in the condition of people with established respiratory disease. It is far more difficult

to assess the role of pollution in relation to the prevalence of chronic bronchitis. There has been much recent work in this field (Lambert and Reid, 1970; Lowe *et al.*, 1970) and there is no doubt that other factors, notably cigarette smoking, are important. The results of many surveys suggest, however, that exposure to pollution may have a bearing on the development of respiratory disease, and exposure in the first few months or years of life may be particularly important (Douglas and Waller, 1966). If this is so, we may have to wait for a whole generation to reap the full benefits of the dramatic reductions in pollution by smoke that have occurred in some areas in recent years. It is encouraging to find, however, that urban/rural differences in bronchitis death rates are becoming smaller, and in London, where the change in pollution has been greatest, there has already been a marked decline in bronchitis mortality (Waller, to be published).

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