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# PNEUMONIA AND ATMOSPHERIC SULPHATE DEPOSIT

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THE fact that pneumonia mortality is higher in urban areas suggests that air pollution has some effect upon the incidence of this disease.

To test such a possibility, pneumonia mortality-rates were calculated for the whole populations of fifty-three county and Metropolitan boroughs in England, Scotland, and Wales, from the Registrar General's annual statistical reviews for the 5-year period 1950–54. These rates were then plotted against the pH of the precipitation, and the atmospheric deposit of tar, ash, other combustible material, and sulphate, using data for single stations and periods within these boroughs taken from the 27th report of the Department of Scientific and Industrial Research on the investigation of atmospheric pollution (1955).

From this preliminary study it was evident that the only one among these components of air pollution showing any obvious relation to pneumonia mortality was sulphate deposit, which presumably depends mainly upon the emission of sulphur dioxide from burning coal.

The correlation of pneumonia mortality with sulphate deposit was then calculated statistically, using the 5-year mortality-rates and the averages of all the sulphate figures given for each of the boroughs during the winter months September to March, when air pollution is usually much worse than in summer. A logarithmic transformation of both variables was made in order to provide more normal frequency distributions and, as far as could be seen, a more adequately linear regression.

The correlation coefficient ($r$) so calculated is $+0{\cdot}35$,

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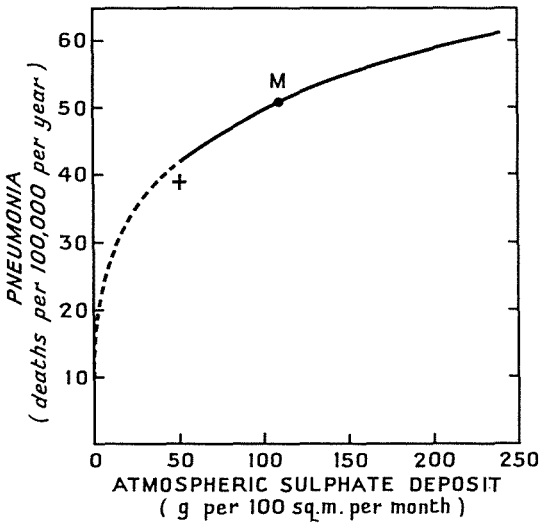


**The relation between pneumonia mortality and winter sulphate deposit in urban areas. M gives the logarithmic mean urban death-rate, and the dotted line extrapolates the curve to low levels of sulphate deposit. Both the average rural sulphate deposit and the rural death-rate from pneumonia are marked by the cross.**

a highly significant value ($P=0{\cdot}01$). The regression equation for the relation between pneumonia mortality ($p$, as deaths per 100,000 of population per year) and winter sulphate deposit ($s$, as g. per 100 sq. m. per month) is $p=16s^{0.25}$.

This relation is shown graphically in the figure, which also shows the death-rate for rural areas in England and Wales over the same period.

It will be seen that the logarithmic mean urban death-rate of 51 per 100,000 persons per year is some 30% higher than the rural death-rate of 39. It must be borne in mind, however, that in Britain the rural population, too, is subjected to air pollution, with the average sulphate deposit in areas outside the main centres of population and industry being about 50g. per 100 sq. m. per month (Meetham 1950). (This is in fact a whole-year average, but according to table 3 of the 27th report of the Department of Scientific and Industrial Research the winter values are not much different from the summer ones where the deposit is low.) Meetham estimates also that the average life of a sulphur-dioxide molecule in the air is about 12 hours, by which time it may well have travelled far from its urban point of origin.

In view of the exposure of the rural population to considerable air pollution, it is of interest to extrapolate the

curve backward to lower levels of sulphate deposit along the dotted line calculated from the equation given above. This extrapolation suggests (although the interpretation cannot be regarded as other than highly speculative) that reduction of sulphur pollution might appreciably reduce pneumonia mortality. This presupposes that the correlation is causal, which of course may not be so, although most investigators think that sulphur dioxide in high concentration has ill effects.

In connection with the association between certain diseases and air pollution, a previous investigation (Gorham 1958) showed a highly significant correlation between bronchitis mortality and the pH of precipitation in the same districts as those examined here. Pneumonia mortality, however, shows no apparent correlation with rain pH, nor, after partial correlation, did bronchitis mortality show a significant correlation with sulphate deposit. The reasons for this difference are obscure, but it seems possible that the ærosol droplets carrying the hydrogen ions are deposited in the bronchi, and do their damage there, while the sulphur, in the form of gaseous sulphur dioxide, penetrates farther and exerts its deleterious effect in the lungs themselves.

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