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# Air pollution and respiratory disease in children and young adults

J. R. T. Colley, BSc, MD, MFCM

*Reader in Paediatric Epidemiology, Department of Medical Statistics and Epidemiology, London School of Hygiene and Tropical Medicine*

IT IS now a matter of history that some 4000 persons died as a direct result of exposure to the severe smog in London in December, 1952. The age groups most affected were the old and middle-aged although there was evidence that children under the age of 1 year also suffered an abrupt increase in mortality. This smog episode served to emphasize the potentially lethal effects of relatively short-term exposure to high levels of pollution, and alerted the public to the possible dangers of air pollution. The 1952 smog was unusually severe and its effects on health obvious; on the other hand little was known at that time about whether long-term exposure to much lower levels of air pollution might also have serious effects upon health. Epidemiologists sought, in studies of working populations and later of children, to answer this question. The studies of children seemed a potentially useful extension of adult studies as they should not suffer from the problems in interpretation that some of the adult studies had highlighted. For example, in adults, cigarette smoking and occupational exposure, both of which might influence the incidence and severity of respiratory disease, could mask or exaggerate possible effects due to air pollution. Children, particularly those in primary school, would not yet smoke sufficiently for this to be an important complication in interpreting possible air pollution effects; in addition they would not yet have been exposed to occupational factors at work.

The classical approach to the study of health effects of exposure to some potentially lethal hazard has been to search for such effects on mortality. This has not been a very rewarding approach in trying to decide the role of air pollution in childhood mortality, due mainly to the apparent impossibility of separating the supposed effects of air pollution from the effects of other important social and environmental factors. Instead, this problem has been approached using field surveys of respiratory morbidity. Much of the early work was carried out in the United Kingdom. Some of these studies involved, for example, young men undergoing examination for National Service. In one such investigation, those young men who came from the industrial areas of south-east Lancashire and Clydeside were found to have higher rates for chronic otitis media than those from the London area. In another study men called up from industrial areas had higher respiratory illness rates while in the army than men called up from rural areas. These findings suggested that urban residence, and particularly residence in the north of England and on Clydeside which would involve exposure to high levels of air pollution, was associated with effects on both the upper and lower respiratory tract. However, these studies used rather crude indices of air pollution exposure and also could not adequately allow for the effects of social and economic factors that are known to influence respiratory disease. It required field surveys, where air pollution exposure and social, economic, and housing factors could be investigated for these findings to be substantiated. During the 1960s various studies, both of pre-schoolchildren and schoolchildren, revealed consistent associations between air pollution exposure and both lower respiratory tract illness and excess prevalence of chest

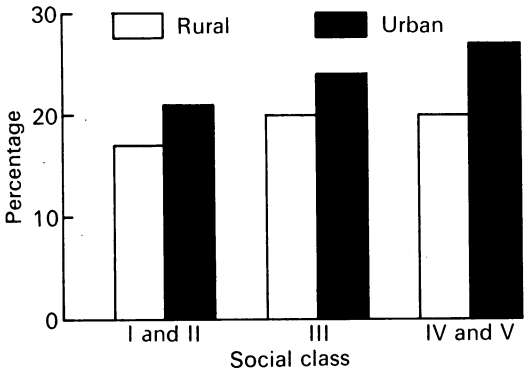


*Fig. 1. Prevalence of bronchitis.*

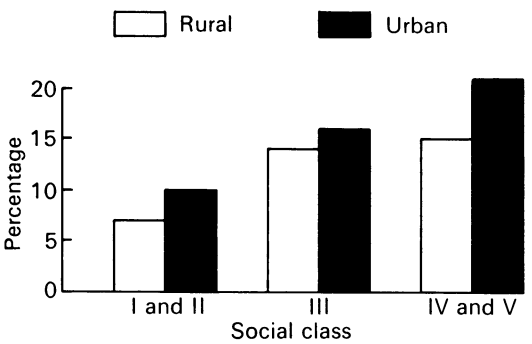


*Fig. 2. Prevalence of cough during the day or night.*

symptoms. In all these studies children exposed to high levels of pollution had higher reported rates for these indices of respiratory disease than children exposed to lower levels. This can be seen in the findings from a large study of primary schoolchildren. In this study children living in 5 rural areas with low exposure to air pollution, and children living in 5 towns with moderate to high air pollution were investigated for their past history of chest illnesses and current respiratory symptoms and signs. The children were also classified on the basis of their parents' occupations into one of five social class groups. As can be seen in *Fig. 1* children in social classes I and II, whose parents would be in professional and managerial occupations, have lower reported rates for bronchitis than children whose parents are in social class III, i.e. skilled workers. In turn, social class III children have lower rates than children with parents in social classes IV and V who would have semi-skilled and unskilled jobs. Within each social class there are higher rates for bronchitis in children from the urban areas. The same urban/rural gradients are found for current cough (*Fig. 2*).

These associations between air pollution exposure and lower respiratory tract disease are similar to those of the other studies in the United Kingdom. However, these studies did not find a consistent association between air pollution and upper respiratory tract disorders; some studies found an association, others did not. In the study mentioned above an association was demonstrated between air pollution exposure and upper respiratory tract disorders. The prevalence of snoring, which is an index of nasal airways obstruction, shows an urban/rural gradient (*Fig. 3*), as does that for ear drum scar and perforation (*Fig. 4*), although the latter finding is subject to there being possible differences in clinical standards in aural examination between the urban and rural areas. The explanation for this lack of consistency

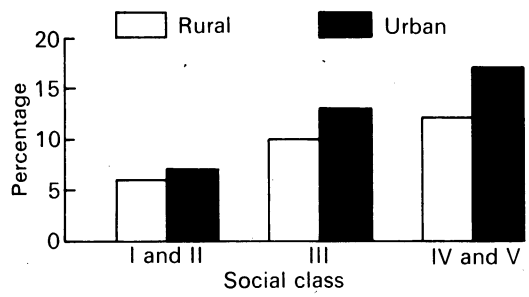


*Fig. 3. Prevalence of snoring.*

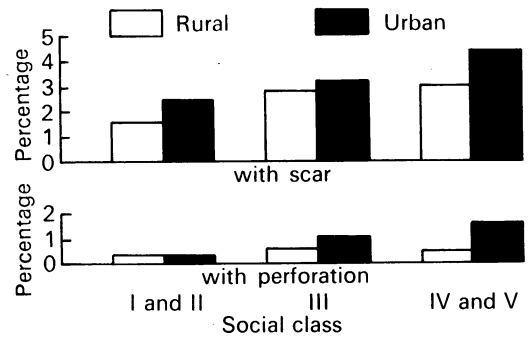


*Fig. 4. Prevalence of disease for ear drums that were seen.*

between studies in their findings on upper respiratory tract disease and air pollution is not clear.

The ventilatory function of the children was also measured in most of these studies, and no association between air pollution levels and ventilatory function was found. However, a study in Japanese children demonstrated that ventilatory function dropped during a period of high air pollution and returned to normal when air pollution returned to lower levels. These findings suggest that while chronic exposure to moderate levels of air pollution does not produce a reduction in ventilatory function, exposure to high levels over shorter periods can cause temporary deficits in these measures.

The studies in the United Kingdom sought information on effects upon children's respiratory tract of exposure to moderate or high air pollution over an extended period. The long-term effects of exposure over a short period of time to very high levels of air pollution is also of interest. In the 1952 smog episode there was evidence of some ' excess ' in deaths among children under the age of 1 year. That infants, as well as the elderly, could die as a result of exposure to very high levels of pollution raises the possibility that such exposure in infancy might, in those who survive, be followed by some permanent damage to the respiratory tract. This suggestion has been investigated by measuring ventilatory function and respiratory symptoms in 800 Londoners who were 18 years old in 1970 and had been exposed in the neonatal period to the 1952 smog. A further group of 800 Londoners, who were 18 years old in 1971 and were therefore born after the smog, were investigated in the same way. Comparison between the prevalence of respiratory symptoms and ventilatory function in these two groups of 18 year olds could not demonstrate any important differences between those exposed to the smog and those who escaped it. The conclusion drawn was that exposure to this smog episode had no dominant effect upon the development of respiratory symptoms up to the age of 18 years. The authors suggested, however, that neonates would have been kept indoors during the smog and might therefore have been exposed to the lower levels of air pollution usually found indoors. Further, in the following years, both groups of children would have been exposed to the high levels of air pollution that London experienced through the 1950s and early 1960s, which might have tended to obscure any earlier differences in respiratory disease caused by the smog exposure between these two groups. It would therefore be unwise at present to conclude that short-term exposures to very high levels of pollution have no long-term effects upon the respiratory tract.

The absence of any firm evidence for long-term health effects following this unique air pollution episode should not divert attention from continuing investigation of air pollution health effects. Most interest must centre on the long-term effects of chronic exposure to lower levels of air pollution, as this exposure is likely to be typical of that affecting major sections of the population. The follow-up of the cohort of births occurring in 1 week in March, 1946 has provided an opportunity to study the effects of air pollution during childhood and also, in the same individuals, in early adult life. The evidence from this study showed clearly, as have other studies already mentioned, that after social class and other factors had been allowed for, the frequency and severity of lower respiratory tract disease in childhood was related to air pollution exposure; these indices increased with increasing level of air pollution exposure.

This cohort was followed until the individuals reached 25 years old. When they were 20 their respiratory symptoms were studied in relation to their lifetime exposure to air pollution. Having taken account of current smoking habits, at this age there did not appear to be any residual effects of air pollution as indicated, for example, by differences in the prevalence of respiratory symptoms between those exposed to high levels of air pollution throughout childhood, and those exposed to low levels. The same findings were observed at age 25. This has suggested that it is in early childhood, particularly in the first few years of life, when susceptibility to the effects of air pollution is greatest; as the children grow up

they become less susceptible so that by early adult life the effects of current and past exposure may not then be apparent.

So far the term 'air pollution' has been used as referring to general environmental pollution of the air, produced mainly by the combustion of fossil fuels. This general air pollution, although mainly affecting the outside air, does penetrate into dwellings, although usually concentrations of pollutants here are lower than outside. Internal air pollution may arise also due to the poor ventilation of domestic heating and cooking appliances. The contribution these sources may have to internal air pollution has not yet been investigated.

A further source of indoor pollution can occur when people smoke, and recently interest has focused upon the effects of such air pollution on non-smokers. Naturally questions have been asked about the effects of such 'passive smoking' on infants and young children. Two recent studies have clearly demonstrated that exposure of infants to cigarette smoke increases the risk of chest illnesses. In one of these studies the risk of such chest illnesses in the infants who were obliged to inhale cigarette smoke was almost double that of the non-exposed infants. This effect seems to occur in the first year of life and not thereafter.

There is little doubt that in the United Kingdom air pollution has had effects upon the incidence of lower respiratory tract illness in infants and young children; the evidence for effects upon the upper respiratory tract are, however, not so clear. In older children, air pollution also has an effect as indicated by the higher prevalence of respiratory symptoms in those exposed to high air pollution. By early adult life the effects of past and of present exposure to air pollution may not be found, although studies of older populations, i.e. those of middle age and older, nevertheless show such effects. The explanation of these different age patterns is not obvious. It seems possible that air pollution, along with other factors, has effects upon the respiratory tract in infancy because of an especial susceptibility at this early age. As children grow up and acquire a more general immunity to respiratory pathogens, susceptibility to the effects of air pollution also diminishes. By middle age, however, due to the prolonged exposure to adverse environmental factors, including air pollution, symptoms and signs of chronic respiratory disease may then appear. If this view of the natural history of respiratory disease is at all close to the truth, it suggests that the least sensitive groups to the effects of air pollution may be older children and young adults. Therefore for the purpose of monitoring the effects of, for example, changing levels of air pollution, infants and young children, and the middle-aged may be the most sensitive groups.

Although major reductions in air pollution in the United Kingdom have followed the Clean Air Act (1956) there is no firm evidence of concurrent changes in the incidence of respiratory disease in children. It should be a source of regret that the opportunities offered by these changing patterns of air pollution have not been exploited sufficiently to monitor their effects, or to investigate the precise role of air pollution in childhood respiratory disease.

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FOR FURTHER READING

COLLEY, J. R. T. (1971), *Br. Med. Bull.* **27**, (1), 9–14.

Dr Colley is Reader in Paediatric Epidemiology in the Department of Medical Statistics and Epidemiology, London School of Hygiene and Tropical Medicine. An early interest in paediatrics while lecturer in the Department of Medicine, St Thomas's Hospital, led to his subsequent research into the epidemiology of respiratory disease and more recently of obesity in families.