data were available and apart from the early study in the United States (Dreessen *et al.*, 1938) the only relevant data came from an asbestos textile factory in England and concerned 290 men, 16 of whom had basal rales. Second, the conclusions could possibly have been biased because they did not include men who had left the factory, some of whom may have had asbestosis. These two criticisms were repeated by Holmes (1973) and Berry (1973). Another criticism was that dust measurements were not available before 1951. Earlier dust levels were taken as 1·5 times those in 1951 and thus underestimated the cumulative exposure of workers employed during those years.

In this paper we give the results of a subsequent study at the asbestos textile factory considered previously (British Occupational Hygiene Society, 1968). In this work both the medical data and the information about exposures have been improved. First, the time over which observations have been made has been extended by 6·5 yr so that the number of man-years of observation is greater. Second, the system of medical surveillance has been made more systematic and comprehensive by the regular use of lung function tests; in addition, technically improved chest radiography with independent multiple readings using the ILO U/C 1971 classification (International Labour Office, 1972) has been introduced. Third, ex-workers co-operated by returning to the factory for a medical examination and chest radiograph. Finally, personnel and departmental records provided details of all the jobs done by all the men.

This additional study was undertaken for the purpose of reviewing the BOHS Hygiene Standard for chrysotile (British Occupational Hygiene Society, 1968; 1973). In this paper we are concerned with presenting data and methods of analysis, but not with recommending standards.

The first section of the paper gives details of the methods used in the study and also gives data on dust levels. The second section considers the relationship of the medical findings to dust exposure. The third section explores different dose-response relationships and their effect on hygiene standards for asbestos. This involves discussion of the problems of mathematical modelling (Appendix).

## Methods

### THE GROUP STUDIED

The earlier, 1968 study was of men who had worked at the asbestos textile factory for 10 years or more, with all their exposure after 1 January 1933, and who were still employed at the factory on 30 June 1966. In the present study the group is extended to include 89 men who had completed 10 years' service between 30 June 1966 and 31 December 1972. Men who had left the factory after 30 June 1966 were included.

There was one man for whom it was not possible to produce an unambiguous job history. In addition, 12 men had worked for several years (at least 7, average 17) in a subsidiary factory, where they were employed in the preliminary treatment of crude asbestos. Dust conditions at this factory are unknown for the period in question, but were probably markedly different from those in the main factory. After excluding these 13 men a total of 379 men remained.

### MEDICAL INFORMATION

For all the men the following were obtained from the records in the factory's medical department:

(i) the most recent chest radiograph;

(ii) the date of the most recent medical examination; the date on which basal crepitations (rales) that did not clear on coughing were first heard; and the date of the previous medical examination;

(iii) the date on which the factory medical officer first suspected possible asbestosis and the date of the previous medical examination;

(iv) the most recent measurement of forced expiratory volume ($FEV_{1.0}$), forced vital capacity (FVC), functional residual capacity (FRC), total lung capacity (TLC), residual volume (RV), transfer factor (TL) by the single breath technique, and pulmonary arterial pressure of carbon dioxide ($PaCO_2$), together with height, weight, and smoking habits. Because tests of pulmonary function were not introduced until 1967, these data were available on only 311, or 82% of the men.

All the men who had left after 30 June 1966 were invited to attend for a chest radiograph and medical examination. Sixty-eight out of 113 (60%) accepted this invitation, 13 (12%) refused or failed to attend, and the remaining 32 (28%) did not reply. However, there were only 20 men still living who had not been seen in 1970 or more recently. None of these 20 men had been certified as suffering from asbestosis by the end of 1975. Ninety-three per cent of the men in the study had been medically examined or had a chest radiograph since 1969 or within three years of death.

The men working in scheduled occupations have periodic medical examinations by a Pneumoconiosis Medical Panel under the Prescribed Diseases Regulations of the National Insurance (Industrial Injuries) Act, 1946. In addition, some men applied to the Panel for certification as having asbestosis. We were allowed access to the records at the Pneumoconiosis Medical Panel for the men in the study and noted whether crepitations had been recorded at