Chronic bronchitis in ex-coal miners working in the steel industry

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Lowe, C. R., and Khosla, T. (1972). *Brit. J. industr. Med.*, **29**, 45-49. **Chronic bronchitis in ex-coal miners working in the steel industry.** Data are presented comparing ventilatory capacity and prevalence of chronic bronchitis in 3 012 ex-coal miners and 9 361 non-miners of similar age and social class, all employed at the time of the investigation in two integrated steel works in South Wales.

The ex-miners had substantially more chronic bronchitis and a poorer ventilatory capacity than the non-miners irrespective of age and smoking habits. Among smokers, 24.9% of ex-miners aged 45 to 54 had chronic bronchitis compared with 18.6% of non-miners. The corresponding prevalence rates among non-smokers of the same age group were 12.0 and 7.7 respectively.

Smoking was a more important factor than coal mining. For example, the non-miners aged 45 to 54 who smoked had a higher prevalence rate of chronic bronchitis (18.6%) than the ex-miners who had never smoked (12.0%). Smoking also appeared to be a more important factor than age. For the non-miners who had never smoked there was no increase in prevalence with age; it remained at about 5% in adult life (25 to 34) until near retirement (55 to 64).

Among the ex-miners the ventilatory capacity showed a decline with increasing number of years spent below ground, with a tendency to level off after 10 to 15 years. The mean ventilatory capacity of ex-miners aged 45 to 54 years who had worked 10 or more years below the ground equalled the mean level of non-miners 10 years older, in the age group 55 to 64 years. The possibility that the movement of bronchitics out of coal mines may explain these differences is discussed.

Four years ago, at the request of the Minister of Pensions and National Insurance, a special committee of the Medical Research Council was set up 'to examine the role of occupation in the aetiology of chronic bronchitis with particular reference to the coal-mining industry'. The committee reported in 1966 and one of its more important conclusions was that 'whereas the inhalation of dust in miners is known to be the cause of pneumoconiosis, the evidence so far does not point to the inhalation of dust as being a major factor in causing bronchitis'. This conclusion provoked some heated exchanges in the correspondence columns of the *British Medical*

Journal and has been discussed in a number of publications (Lowe, 1968 and 1969; Ryder, Lyons, Campbell, and Gough, 1970; Gilson, 1970).

There is no doubt that coal miners have higher mortality and morbidity rates from chronic bronchitis and lower ventilatory capacities than men of the same age in other occupations of comparable social class. If exposure to coal dust plays an important part in promoting these differences, clear evidence of a dose-response relationship would be expected. So far the evidence on this point is curiously unconvincing. A number of careful studies, after allowing for age and smoking habits, have shown

only a modest and uncertain association between the prevalence of chronic bronchitis or the level of ventilatory capacity and years spent at the coal face (Higgins, Oldham, Cochrane, and Gilson, 1956; Higgins, Cochrane, Gilson, and Wood, 1959; Higgins and Cochrane, 1961). Other studies have shown that the relation between category of simple pneumoconiosis and the prevalence of bronchitis is also very weak (Gilson, 1963; Ashford, Brown, Morgan, and Rae, 1968). It is largely on these grounds that the M.R.C. Committee concluded that 'on present evidence intensity of dust exposure does not appear to be a very significant factor in determining the prevalence of bronchitis in coal miners'. And there the matter still rests.

As Gilson (1970) has pointed out, what is now needed is a prospective study of attack rates of bronchitis in cohorts of men entering the coal mines in relation to regular measurement of the dust levels to which they are exposed. The National Coal Board Pneumoconiosis Field Research Scheme is accumulating data of this type and we await their publication with interest. In the meantime we must continue to study such retrospective collected data as are available.

In this paper we compare ventilatory capacity and the prevalence of chronic bronchitis in 3012 ex-miners and 9361 non-miners of similar age and social class, all employed at the time of the investigation in two integrated steel works in South Wales.

Material and methods

The data were collected in 1964 and 1965 as part of an epidemiological study of respiratory symptoms and ventilatory capacity in relation to atmospheric pollution in and around two large integrated steel works in South Wales (Lowe *et al.*, 1968; Warner, Davies, Jones, and Lowe, 1969; Lowe, Campbell, and Khosla, 1970). The two works were the Ebbw Vale Works of Richard Thomas and Baldwins Limited, with a population of about 9500 men, and the Margam and Abbey Works of the Steel Company of Wales Limited at Port Talbot, with a population of about 16500 men. During the course of this investigation 8081 men at Ebbw Vale and 10863 men at Port Talbot were interviewed and examined.

A full description of the methods by which information about respiratory symptoms and ventilatory capacity was collected for each of these men has been published elsewhere (Lowe *et al.*, 1968). For the purposes of this paper it is sufficient to say that respiratory symptoms were recorded on the M.R.C. (1960) standardized questionnaire, and ventilatory capacity (FEV_1 and FVC) was measured on the Garthur Vitalograph which gives a permanent tracing of forced ventilatory output.

About one in four of the men employed in the steel works gave a history of having at some time worked as a coal miner below ground. In the present study we have excluded men under 25 and over 65, men employed at the steel works in occupations falling into the Registrar General's social classes I and II, men known to have

pneumoconiosis, and ex-smokers. This left us with 12 373 men of whom 3 012 (24.3%) had at some time worked at the coal face (ex-miners); 403 of the 3012 ex-miners (13.4%) and 1802 of the 9361 non-miners (19.2%) were non-smokers and had never smoked more than one cigarette a day, or its equivalent in other forms of tobacco, for as long as one year (Table 1).

TABLE 1
DISTRIBUTION OF MEN BY AGE, SMOKING CATEGORY,
AND HISTORY OF COAL MINING

Smoking category and history of mining	Age (years)				All ages
	25-34	35-44	45-54	55-64	
Smokers					
Ex-miners ..	281	737	838	753	2609
Non-miners ..	1812	2483	2080	1184	7559
Non-smokers					
Ex-miners ..	66	127	125	85	403
Non-miners ..	748	510	378	166	1802
Smokers and non-smokers combined					
Ex-miners ..	347	864	963	838	3012
Non-miners ..	2560	2993	2458	1350	9361
Total	2907	3857	3421	2188	12373

For the calculation of prevalence rates we have defined chronic bronchitis in terms of the M.R.C. questionnaire as 'persistent cough and phlegm ("Yes" to questions 5 and 10) with one or more of the three complications—spells of increased cough and phlegm ("Yes" to 12a) and/or absence from work because of chest illness ("Yes" to 14b) and/or shortness of breath ("Yes" to 21).' The measure of ventilatory capacity we have used is FEV_1 as a percentage of FVC. For statistical purposes this has the advantage over FEV_1 that it is unrelated to height (Lowe *et al.*, 1968). It is also a more sensitive index of bronchiolar obstruction, which is of course an important feature of chronic bronchitis.

Results

In Fig. 1 we compare the prevalence of chronic bronchitis (as defined) among the steel workers at Ebbw Vale and at Port Talbot who had at some time worked as coal miners with its prevalence among men who had never worked below ground. At each of the two works and for each age group the ex-miners who were currently smoking had more bronchitis than the non-miners and the same was true for the ex-miners and non-miners who had never smoked (except at age 25 to 34 for Ebbw Vale). The prevalence of bronchitis in relation to age was very similar in the two works, so in subsequent tables and figures data from the two works have been combined.

FIG. 1. Prevalence of chronic bronchitis in two steel works by history of coal mining and smoking category

Table 2 and Fig. 2 underline the difference between ex-miners and non-miners in their experience of chronic bronchitis. For each age and smoking group ex-miners had more bronchitis than non-miners. At age 55 to 64 the prevalence of bronchitis among smokers was about one-third higher for ex-miners (35.6%) than for non-miners (27.3%); among the non-smokers it was four times higher for ex-miners (22.4%) than for non-miners (5.4%). Nevertheless, smoking appeared to be a more important factor than coal mining, for at each age non-miners who smoked had consistently more chronic bronchitis than ex-miners who had never smoked. Interestingly, although the prevalence of bronchitis among smokers was high and increased

FIG. 2. Prevalence of chronic bronchitis by history of coal mining and smoking category (two works combined).

steeply with age, among non-miners who had never smoked it was not only much lower but showed little or no tendency to increase with age (e.g., 4.9% of the non-smoking non-miners had chronic bronchitis at age 25 to 34 and 5.4% of them had it at age 55 to 64).

When ventilatory capacity $FEV_1\%$ was used as a measure of respiratory disability similar differences were apparent (Table 3 and Fig. 3). Among the smokers and among the non-smokers, ex-miners at each age (except at age 25 to 34 for smokers) had lower ventilatory capacities than non-miners. But, as for chronic bronchitis, the influence of smoking was so marked that the non-miners who smoked were more disabled, age for age, than the ex-miners who had never smoked. The decline of ventilatory capacity $FEV_1\%$ with age was much less steep for non-smokers than for smokers, to the extent that for the non-smoking non-miners it fell by only 4.3% (from 82.3 to 78.0) over the 30 years between the two age groups 25 to 34 and 55 to 64 whereas the correspond-

TABLE 2

PREVALENCE OF CHRONIC BRONCHITIS BY AGE, SMOKING CATEGORY, AND HISTORY OF COAL MINING

Smoking category and history of mining	Percentage of men with chronic bronchitis at ages:			
	25-34	35-44	45-54	55-64
Smokers				
Ex-miners ..	13.2	20.4	24.9	35.6
Non-miners ..	10.7	14.2	18.6	27.3
Non-smokers				
Ex-miners ..	9.1	11.8	12.0	22.4
Non-miners ..	4.9	5.5	7.7	5.4

TABLE 3

VENTILATORY CAPACITY ($FEV_1 \times 100/FVC$) BY AGE, SMOKING CATEGORY, AND HISTORY OF COAL MINING

Smoking category and history of mining	$FEV_1 \times 100/FVC$ at ages:			
	25-34	35-44	45-54	55-64
Smokers				
Ex-miners ..	79.7	74.9	72.2	68.1
Non-miners ..	79.7	77.2	73.7	70.7
Non-smokers				
Ex-miners ..	81.0	77.3	75.5	73.2
Non-miners ..	82.3	79.9	78.7	78.0

FIG. 3. Ventilatory capacity ($FEV_1 \times 100/FVC$) by history of coal mining and smoking category.

ing fall for ex-miners who smoked was 11.6% (from 79.7 to 68.1).

Clearly, in our population of steel workers in South Wales, the men who had at some time worked as coal miners had more chronic bronchitis and a doorer ventilatory capacity than the men who had never worked below ground. We now turn to examine whether or not there is any relation between the number of years the ex-miners had worked at the face and the degree of their respiratory disability. Table 4 and Fig. 4 relate $FEV_1\%$ among currently smoking ex-miners aged 45 to 54 and 55 to 64 to the number of years that they had worked below ground. Because of small numbers it was not possible to present the same tabulation for the non-smoking ex-miners. For both age groups ventilatory capacity showed a decline with increasing number of years

spent below ground with a tendency to level off after 10 to 15 years. The decline was so marked that the weighted mean of $FEV_1\%$ among ex-miners 45 to 54 years of age who had spent 10 or more years below ground (2nd column, Table 4) was the same as the mean $FEV_1\%$ for non-miners in the older age group 55 to 64 (70.7) and this had nothing to do with the mean number of cigarettes smoked per day.

Discussion

Our data show quite clearly that one-time coal miners now working in the steel works at Ebbw Vale and Port Talbot in South Wales have substantially more chronic bronchitis and a poorer ventilatory capacity than fellow steel workers who have never worked at the coal face. This cannot be attributed to different smoking habits. Indeed, the difference between the ex-miners and the non-miners was greater among the non-smokers than among the

FIG. 4. Ventilatory capacity among smoking ex-miners by number of years worked below ground.

TABLE 4
VENTILATORY CAPACITY ($FEV_1 \times 100/FVC$) AMONG SMOKING EX-MINERS AGED 45 TO 54 AND 55 TO 64 BY NUMBER OF YEARS WORKED BELOW GROUND

No. of years worked below ground	Ages 45 to 54			Ages 55 to 64		
	FEV_1/FVC %	Cigs. ¹ per day	No. of men	FEV_1/FVC %	Cigs. ¹ per day	No. of men
Miners						
Less than 5	73.6	20.0	268	70.0	17.7	224
5-9	73.3	18.4	186	68.4	18.8	133
10-14	70.5	18.4	129	67.0	16.7	127
15-19	71.2	18.8	71	66.0	18.3	93
20 and over	70.7	19.6	184	67.2	18.6	176
Non-miners	73.7	18.9	2080	70.7	18.3	1184

¹Cigarette equivalents

smokers. Our data also show that the impairment of ventilatory capacity among the ex-miners was related to the number of years they had spent below ground, so much so that men of 45 to 54 who had spent 10 or more years at the coal face had the same FEV₁% as non-miners who were 10 years older (55-64).

This evidence, and in particular the suggestion of a dose-response in terms of years spent below ground, appears to support the contention that the known excess of morbidity and mortality from bronchitis among coal miners is the direct consequence of their work at the coal face and not, as the Report of the Medical Research Council (1966) concluded, the consequence of more general socio-economic or environmental factors. However, a note of warning must be sounded. Data of this type need to be interpreted with caution. We have no way of determining whether or not the coal miners we have examined were representative of the coal-mining population from which they came. In fact there is likely to have been at least some degree of selective withdrawal out of the coal industry and selective entry into the steel industry. For example, the ex-miners may have left the coal mines because they realized that they were developing a respiratory disability and so may have had a higher prevalence of chronic bronchitis than the general population of coal miners of the same age and years of exposure. On the other hand, ex-miners with bronchitis may have tended to avoid, if possible, occupations in the steel industry, which they may have believed would expose them to lung irritants. On balance, and with our knowledge of the localities concerned, we do not think that selective movement either out of the coal mines or into the steel works is likely to have introduced a serious bias. But this is of course a matter of opinion, not fact.

Our data make two further points of interest. The first is that even if the excess of bronchitis among the ex-miners is directly attributable to dust exposure, smoking is more harmful than coal mining. The non-miners who smoked, had, age for age, more bronchitis and a poorer ventilatory capacity than the ex-miners who had never smoked. The second is that in the absence both of smoking and of a history of coal mining there was no increase in the prevalence of chronic bronchitis with age; it remained at about 5% in adult life until near retirement.

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