

SEASONAL VARIATIONS IN THE MEASUREMENT OF VENTILATORY CAPACITY AND IN THE ANSWERS OF WORKING COAL MINERS TO A RESPIRATORY SYMPTOMS QUESTIONARY

BY

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The Pneumoconiosis Field Research of the National Coal Board has already been described (Fay, 1957; Fay and Rae, 1959; Rogan, Ashford, Chapman, Duffield, Fay, and Rae, 1961). It includes a series of medical surveys carried out at 25 collieries, each of which is visited at intervals of about 5 years. Every man presenting himself for examination has a 14" × 14" postero-anterior chest radiograph taken and his Forced Expiratory Volume over 1 second (F.E.V.₁), Forced Vital Capacity (F.V.C.), standing height, sitting height, and weight measured. In addition he is asked a questionnaire about respiratory symptoms (Appendix).

Two Medical Units are involved in the surveys and, since it is hoped to combine the results obtained by each Unit over a period of years, trials are held to ensure that the techniques of the two clerks asking the questionnaire and the two technicians taking the physiological measurements are consistent. The trials are also designed to confirm that the accuracy and comparability of the apparatus used for the measurement of ventilatory function is maintained.

In spite of these precautions, the possibility of systematic variations in the subjects themselves from survey to survey cannot be excluded. For example, if surveys are carried out at different times of the year, with consequent changes in the weather and in levels of atmospheric pollution, systematic differences in both measurements of ventilatory capacity and answers to the respiratory symptoms questionnaire may occur.

In order to investigate such an effect, measurements of ventilatory function and of the prevalence of respiratory symptoms were made at two collieries each of which was visited at intervals of 6 months;

one in June, 1960, and January, 1961, and the other in June, 1962, and January, 1963.

METHODS

The techniques used in the physiological measurements of the Pneumoconiosis Field Research have been described by Ashford, Forwell, and Routledge (1960). The respiratory questionnaire used by the Pneumoconiosis Field Research at the time of this investigation differed from that described by Rogan and others (1961). The main difference consisted of two additional questions, 1A and 4A, which were used to clarify the original questionnaire and to obtain further information. The definition of smokers had also been changed to fall in line with other workers in this field, though unpublished comparisons suggest that a similar prevalence is obtained whichever form is adopted.

Because of the difficulty of defining chronic bronchitis, the concept of a respiratory symptom complex consisting of various combinations of positive answers to questions was used; this is described in the Appendix. The clerk was instructed that, if a straightforward "Yes" or "No" to a question was not obtained, he should say "I know this may be difficult, but please try to answer Yes or No". If again a straightforward "Yes" or "No" was not obtained, a "No" was recorded. Recordings of some interviews were made and samples monitored at the end of each day to ensure that no inconsistencies arose in the administration of the questionnaire. On all four surveys, measurements of ventilatory function were obtained by the same technician and the same clerk asked the respiratory symptoms questionnaire. There were no variations in techniques or methods.

After consideration of the varying working environments of the men and the relatively large area throughout which their homes were situated, it appeared impractical to record indices pertaining to the variation in weather or degree of atmospheric pollution. Therefore no specific correlations could be attempted between changes in these factors and alterations in ventilatory capacity or answers to the respiratory symptoms questionnaire.

Colliery 1 is situated in an urban area in North-umberland. During the first visit in June, 1960, which was part of the normal survey programme, the weather was bright, sunny, and with average temperatures for the time of the year. In January, 1961, the weather was cold and wet with showers of sleet. No fog was noted. The results obtained from the examination of 710 men were available for analysis and comprised 88.8 per cent. of the total number of men working at the colliery at the time of the June, 1960, survey. F.V.C. measurements were not made at this colliery on either visit.

Colliery 2 lies between rural and urban areas in Yorkshire, with two industrial conurbations within a radius of 10 miles. The first visit in June, 1962, was also part of the normal survey programme. The weather was wet, windy, and cool for the time of the year. In January, the snow lay thick and temperatures were well below freezing for most of the time. The thaw had not set in before completion of the survey. Duplicate measurements of both the F.E.V.₁ and the F.V.C. of 991 men (82.7 per cent. of the total employed at the colliery at the time of the June, 1962, survey) were analysed. The number is less than the total examined. One man was unable to perform the

tests and the results of twenty men whose F.V.C. measurements were higher than the maximum reading of the apparatus have been discarded.

RESULTS

(A) VENTILATORY CAPACITY

(i) F.E.V.₁.—The differences in the results obtained on the two surveys carried out at each colliery have been sub-divided in terms of age, smoking habits, and presence or absence of the respiratory symptoms complex as recorded at the time of the first survey. They are shown in Table I. At both collieries there was a decrease in the average F.E.V.₁ measured during the January examinations when compared with those recorded in the previous June. This remained true when the men were sub-divided according to smoking habits and presence or absence of the respiratory symptoms complex. From the standard errors quoted, it will be seen that all the differences were significant. When the effect of age was considered, the differences in F.E.V.₁ at Colliery 1 tended to increase with increasing age from 0.014 litres in the under 21 years of age group to 0.136 litres for the 51–60 year age group. A similar trend was seen for Colliery 2. The difference was 0.08 litres for the under 21 years of age group rising to 0.201 litres for the 41–50 year age group. The difference for the 51–60 years of age group was somewhat lower. The mean difference of 0.143 litres at Colliery 2 was significantly higher than the corresponding figure of 0.106 litres at Colliery 1. At both pits, the mean differences in F.E.V.₁ for the ex-smokers was greater than that for the smokers or non-smokers, and that

TABLE I
DIFFERENCE IN MEASUREMENTS OF F.E.V.₁ AT TWO COLLIERIES

Age* (yrs)	Respiratory* Symptoms	Smoking Habits*	Colliery 1 June, 1960, and January, 1961			Colliery 2 June, 1962, and January, 1963				
			No. of Men	Mean Difference in F.E.V. (litres)		No. of Men†	Mean Difference in F.E.V. (litres)		Mean Difference in F.V.C. (litres)	
				Value	Standard Error		Value	Standard Error	Value	Standard Error
All	All	Smokers	568	0.109	0.010	746	0.148	0.011	0.128	0.012
		Non-smokers	98	0.073	0.026	157	0.110	0.025	0.065	0.028
		Ex-smokers	44	0.147	0.028	88	0.161	0.028	0.190	0.031
All	With Without	All	116	0.128	0.026	186	0.160	0.027	0.165	0.029
			594	0.102	0.009	805	0.139	0.010	0.114	0.011
Under 21	All	All	53	0.014	0.023	58	0.080	0.033	-0.007	0.036
21-30			117	0.095	0.026	113	0.080	0.031	0.048	0.028
31-40			131	0.102	0.019	212	0.140	0.018	0.118	0.020
41-50			168	0.112	0.017	288	0.201	0.018	0.187	0.020
51-60			198	0.136	0.017	249	0.128	0.020	0.117	0.022
Over 60			43	0.106	0.033	71	0.120	0.032	0.134	0.037
All	All	All	710	0.106	0.009	991	0.143	0.009	0.124	0.010

* Based on June, 1960 Survey for Colliery 1 and on June, 1962 Survey for Colliery 2.

† One man (non-co-operator) and twenty men, whose F.V.C. measurements were higher than readings available on the apparatus, have been excluded.

for the smokers was greater than the corresponding figures for the non-smokers. There were wide individual variations in the F.E.V.₁ values recorded on the two occasions. At Colliery 1, differences in F.E.V.₁ of 0·4 litres or more were recorded for 12·5 per cent. of the men examined and differences of 0·2 litres or more for just under 40 per cent. The corresponding figures for Colliery 2 were 16·3 and 45·3 per cent.

The larger changes in F.E.V. occurred more frequently in men with respiratory symptoms and in the older age groups, but did not appear to bear any consistent relation to smoking habits.

(ii) F.V.C.—This was measured at Colliery 2 only and the differences in the individual measurements between the surveys are also summarized in Table I. The mean difference for the population as a whole and the various smoking and respiratory symptoms groups again showed that values observed in June were higher than those recorded in January. The differences were rather smaller than those found for the F.E.V.₁ but were again statistically significant. When sub-divided by age, the under 21 years age group showed a slight rise in the January values as compared with June, but the difference was not significant. Otherwise the pattern for the mean differences in F.V.C. followed the pattern for the mean differences in F.E.V.₁. There were wide variations in the F.V.C. values recorded on the two

surveys for certain individuals. Some 17·9 per cent. of the men examined showed differences of more than 0·4 litres and 46·1 per cent. showed differences of 0·2 litres. The larger differences in F.V.C. were distributed in terms of age, respiratory symptoms, and smoking habits in a similar way to the larger differences in F.E.V.₁.

(B) RESPIRATORY SYMPTOMS AND SMOKING HABITS

At Colliery 1 the prevalence of respiratory symptoms reported in January, 1961, tended to be higher than that reported in June, 1960. The proportion of men with the respiratory symptoms complex rose by 1·7 per cent. between the two surveys. The symptoms which showed the highest rises in prevalence were weather affecting the chest, morning phlegm and morning cough, which increased by 9·8, 7·5, and 6·9 per cent. respectively. Symptoms with a very slightly reduced prevalence were breathlessness and wheeze which decreased by 0·3 and 0·4 per cent., while the incidence of previous chest illnesses fell in January, 1961, by 0·8 per cent.

At Colliery 2, the difference in the incidence of respiratory symptoms between the two surveys was larger. During the winter survey the prevalence of the respiratory symptoms complex rose by 6 per cent. The prevalence of persistent morning cough, weather affecting the chest and wheeze rose by 11·5, 10·5, and 6·1 per cent. respectively. Only one

TABLE
COMPARISON OF PREVALENCE (per cent.) OF INDIVIDUAL
(a) Present/Present
(b) Present/Absent

Symptom	Colliery 1 (710 men) Comparison between June, 1960, and January, 1961							
	Prevalence of Various Combinations of Symptoms (June, 1960/January, 1961)				Overall Prevalence of Symptoms		Prevalence of Inconsistent Answers (b) + (c)	Proportions of Men giving Inconsistent Answers with Symptoms Absent in June, 1960 (c) (b) + (c)
	(a)	(b)	(c)	(d)	June, 1960 (a) + (b)	January, 1961 (a) + (c)		
1. Morning cough ..	41·5	7·9	14·8	35·8	49·4	56·3	22·7	0·65*
1a. Persistent morning cough ..	22·0	7·6	11·7	58·7	29·6	33·7	19·3	0·61*
2. Cough all day ..	11·1	7·0	9·4	72·4	18·2	20·6	16·5	0·57
3. Persistent cough all day ..	7·6	5·4	6·9	80·1	13·0	14·5	12·3	0·56
4. Morning phlegm ..	28·3	8·0	15·5	48·2	36·3	43·8	23·5	0·66*
4a. Persistent morning phlegm ..	15·2	4·9	9·3	70·6	20·1	24·5	14·2	0·65*
5. Phlegm all day ..	10·0	6·2	7·9	75·9	16·2	17·9	14·1	0·56
6. Persistent phlegm all day ..	7·2	5·6	6·3	80·8	12·8	13·5	12·0	0·53
7. Breathlessness ..	5·5	3·7	3·4	87·5	9·2	8·9	7·0	0·48
8. Wheeze ..	8·7	5·9	5·5	79·9	14·6	14·2	11·4	0·48
9. Weather affects chest ..	9·4	3·1	12·8	74·6	12·5	22·3	15·9	0·81*
14. Previous chest illness ..	7·9	7·7	6·9	77·5	15·6	14·8	14·6	0·47
3 and 6 ..	5·1	3·7	4·9	86·3	8·7	10·0	8·6	0·57
3 or 6 ..	10·4	6·6	7·6	75·4	17·0	18·0	14·2	0·53
8 and 9 ..	5·8	3·1	5·4	85·8	8·9	11·1	8·5	0·63*
R.S. Complex ..	11·0	5·4	7·0	76·6	16·3	18·0	12·4	0·57

* Proportion significantly different from 0·5

symptom, breathlessness, showed a fall (2.2 per cent.) between June, 1962, and January, 1963.

The last columns for each colliery in Table II show the proportions of the men giving inconsistent answers to the various questions, and who denied having the particular symptom on the first (summer) survey. If there was no tendency towards any excess of the symptoms during the second survey, the expected value of the proportion would be 0.5 and significant deviations from this figure are indicated. Individual symptoms showing a significant increase at the time of the second survey at both collieries were morning cough, persistent morning cough, morning phlegm, persistent morning phlegm, and weather affecting the chest. Inconsistent replies to questions about individual symptoms (Table II) varied widely from 23.5 per cent. for morning phlegm to 7 per cent. for breathlessness at Colliery 1 and 23.1 per cent. for persistent morning cough to about 11.0 per cent. for persistent cough all day, persistent phlegm all day, and breathlessness at Colliery 2. As a consequence of inconsistent replies to individual symptoms, inconsistencies in the respiratory symptoms complex amounted to 12.4 per cent. at Colliery 1 and 12.5 per cent. in Colliery 2.

The distribution of numbers of inconsistent replies to the respiratory symptoms questionnaire is shown in Table III (overleaf). Answers to each of the questions numbered 1-9, together with 1a, 4a, 14, and the combinations of answers comprising the

respiratory symptoms complex, were treated separately; the total number of replies analysed was thus thirteen. Only 35.2 per cent. of the men gave consistent replies to all questions at Colliery 1 and 31.6 per cent. at Colliery 2. As might be expected on general grounds, the proportion of men giving inconsistent replies to the individual symptoms tended to increase with increasing prevalence, and was most marked amongst the men with the respiratory symptoms complex. Non-smokers were, on the whole, considerably more consistent than the smokers or ex-smokers. The corresponding percentages of inconsistent replies for men with the respiratory symptoms complex were 12.9 and 17.6 per cent. The proportion of men whose inconsistent replies were in both directions (answers either Yes/No or No/Yes) on the two surveys was also determined. At Colliery 1, 14.6 per cent. of the men fell into this category, compared with 16.5 per cent. at Colliery 2. For men with the respiratory symptoms complex the corresponding figures were 27.6 and 31.6 per cent.

The replies to questions about smoking habits are given in Table IV (overleaf, pp. 94 and 95) for both collieries. There was a high degree of consistency in the numbers of men reported as smokers, non-smokers, and ex-smokers at each pair of surveys. However, three men at Colliery 1 and thirteen men at Colliery 2 reported changes which were impossible according to the definitions used in their assessment (smoker to non-smoker, ex-smoker to non-smoker).

II

RESPIRATORY SYMPTOMS AND COMBINATIONS OF SYMPTOMS

(c) Absent/Present
(d) Absent/Absent

Colliery 2 (1,012 men) Comparison between June, 1962, and January, 1963								Symptom
Prevalence of Various Combinations of Symptoms (June, 1962/January, 1962)				Overall Prevalence of Symptoms		Prevalence of Inconsistent Answers (b)+(c)	Proportion of Men giving inconsistent Answers with Symptoms Absent in June, 1962 (c) (b)+(c)	
(a)	(b)	(c)	(d)	June, 1962 (a)+(b)	January, 1963 (a)+(c)			
44.8	8.3	14.4	32.5	53.1	59.2	22.7	0.63*	1
27.7	5.8	17.3	49.2	33.5	45.0	23.1	0.75*	1a
17.8	7.0	10.5	64.7	24.8	28.3	17.5	0.60*	2
12.3	4.5	6.6	76.6	16.8	18.9	11.2	0.59*	3
33.9	9.5	13.2	43.4	43.4	47.1	22.7	0.58*	4
16.7	7.3	13.8	62.2	24.0	30.5	21.1	0.65*	4a
12.8	6.6	9.9	70.7	19.5	22.7	16.5	0.60*	5
9.2	5.0	5.9	79.8	14.2	15.1	11.0	0.54*	6
7.5	6.6	4.3	81.5	14.1	11.9	11.0	0.40*	7
12.2	4.1	10.2	73.6	16.2	22.3	14.2	0.72*	8
18.0	5.2	15.7	61.1	23.2	33.7	20.9	0.75*	9
16.6	7.5	12.2	63.7	24.1	28.8	19.7	0.62*	14
9.2	5.0	5.9	79.8	14.2	15.1	11.0	0.54*	3 and 6
12.3	4.5	6.6	76.6	16.8	18.9	11.2	0.59*	3 or 6
9.3	2.9	9.7	78.2	12.2	19.0	12.5	0.77*	8 and 9
15.2	3.3	9.3	72.2	18.5	24.5	12.5	0.74*	R.S. Complex

At both collieries the consumption of cigarettes in January was significantly less than in June, but the consumption of pipe tobacco showed little alteration. The difference in cigarette consumption could well have been a real change.

DISCUSSION

The disastrous effect of exceptional pollution on the mortality and morbidity of cardiac and respiratory disease is well known (Firket, 1936; Schrenk, Heimann, Clayton, Gafafer, and Wexler, 1949; Logan, 1953). Holland, Spicer, and Wilson (1961)

found that both atmospheric pollution and low temperature had independent effects on the admission to London hospitals of patients aged more than 15 years, suffering from acute respiratory disease. The effect of cold was confirmed from sickness notifications in certain R.A.F. recruit stations. Stuart-Harris and Hanley (1957) postulate an analogy between the effect of smog and chronic atmospheric pollution and acute and chronic infection of the respiratory tract. Work supporting the view that both acute and chronic pollution is deleterious is reviewed by Farber and Wilson (1962). Many

TABLE III
DISTRIBUTION PER CENT. OF INCONSISTENT REPLIES TO VARIOUS QUESTIONS ON THE SURVEYS

Colliery	Smoking Habits*	Respiratory Symptoms*	Total No. of Men	No. of Questions to which Replies were Inconsistent													
				0	1	2	3	4	5	6	7	8	9	10	11	12	13
(1) Surveys carried out in June, 1960, and January, 1961	Cigarette Smokers	With	103	12.6	15.5	11.7	14.6	11.7	10.7	7.8	6.8	3.9	2.9	1.0	1.0	0.0	0.0
		Without Both	412	35.2	21.1	16.7	10.9	5.6	2.7	3.2	2.4	0.7	1.0	0.2	0.2	0.0	0.0
	Pipe Smokers	With	4	0.0	0.0	25.0	0.0	25.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0
		Without Both	32	37.5	9.4	28.1	12.5	6.2	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cigarette and Pipe Smokers	With	1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Without Both	16	25.0	18.8	12.5	6.2	25.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	All Smokers	With	108	13.0	14.8	12.0	13.9	12.0	10.2	7.4	6.5	5.6	2.8	0.9	0.9	0.0	0.0
		Without Both	460	35.0	20.2	17.4	10.9	6.3	3.0	2.8	2.4	0.7	0.9	0.2	0.2	0.0	0.0
	Non-smokers	With	2	50.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Without Both	96	60.4	15.6	9.4	10.4	1.0	0.0	2.1	0.0	0.0	0.0	1.0	0.0	0.0	0.0
Ex-smokers	With	6	0.0	0.0	16.7	16.7	16.7	16.7	16.7	16.7	16.7	0.0	0.0	0.0	0.0	0.0	
	Without Both	38	42.1	20.5	15.9	9.1	7.9	0.0	2.3	2.3	4.5	9.1	0.0	0.0	0.0	0.0	
All Men	With	116	12.9	13.8	12.1	13.8	12.1	10.3	8.6	6.9	5.2	2.6	0.9	0.9	0.0	0.0	
	Without Both	594	39.6	19.7	16.0	10.6	5.1	2.4	2.7	2.4	0.5	0.7	0.3	0.2	0.0	0.0	
(2) Surveys carried out in June, 1962, and January, 1963	Cigarette Smokers	With	150	18.0	18.0	23.3	8.0	14.0	6.7	3.3	3.3	3.3	1.3	0.7	0.0	0.0	
		Without Both	527	28.5	16.5	19.4	10.4	8.2	5.5	3.6	2.5	2.1	1.1	1.3	0.8	0.2	0.0
	Pipe Smokers	With	9	11.1	11.1	33.3	0.0	22.2	11.1	11.1	0.0	0.0	0.0	0.0	0.0	0.0	
		Without Both	54	25.9	22.2	5.6	9.3	7.4	14.8	3.7	3.7	5.6	1.9	0.0	0.0	0.0	
	Cigarette and Pipe Smokers	With	2	50.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		Without Both	15	13.3	20.0	20.0	26.7	6.7	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	All Smokers	With	161	18.0	17.4	24.2	7.5	14.3	6.8	3.7	3.1	3.1	1.2	0.6	0.0	0.0	
		Without Both	596	27.9	17.1	18.1	10.7	8.1	6.4	3.5	2.7	2.3	1.2	1.2	0.7	0.2	
	Non-smokers	With	11	9.1	0.0	9.1	18.2	9.1	27.3	0.0	9.1	0.0	0.0	9.1	9.1	0.0	
		Without Both	156	60.9	16.0	10.9	4.5	4.5	0.6	0.0	0.6	0.6	0.6	0.6	0.6	0.0	
Ex-smokers	With	15	20.0	6.7	13.3	20.0	6.7	6.7	0.0	6.7	13.3	0.0	0.0	6.7	0.0		
	Without Both	73	35.6	15.1	17.8	6.8	11.0	5.5	2.7	2.7	0.0	0.0	2.7	0.0			
All Men	With	187	17.6	15.5	22.5	9.1	13.4	8.0	3.2	3.7	3.7	1.1	1.1	1.1	0.0		
	Without Both	825	34.8	16.7	17.8	9.2	7.6	5.2	2.8	2.3	1.8	1.0	1.1	0.6	0.1		
	With	1,012	31.6	16.5	17.8	9.2	8.7	5.7	2.9	2.6	2.2	1.0	1.1	0.7	0.1		
	Without Both																

* Based on June, 1960, Survey for Colliery 1 and June, 1962, Survey for Colliery 2.

sufferers from respiratory disease complain that some types of weather adversely affect their chest symptoms, even when a rise in atmospheric pollution is not obvious. Objective evidence on this point is not decisive. Waller and Lawther (1957) asked their patients to keep a diary recording their chest condition. The observations were translated into a simple scoring system, and a close correlation was found between clinical condition and atmospheric smoke concentration. McKerrow (1960), after observing a small but probably not very representative sample of workers, has suggested that as far as the F.E.V.₁ is concerned, small seasonal changes do take place. He found a slow decline from a summer peak to a winter trough occurring about January–February. Spicer, Storey, Morgan, Kerr, and Standiford (1962) found that their patients with respiratory disease became better or worse together, suggesting a causal environmental factor, although no specific air pollutant could be incriminated. Schoettlin (1962) found that subjects who had lived in certain geographical areas reported an excess of cough, sputum, shortness of breath, and previous chest illness. He could not find any correlation between clinical findings, and effects of weather, air pollution, or pollen in a population of elderly males living in Los Angeles. Rokaw and Massey (1962) could not find any cyclical effect of weather or smog on patients with severe chronic respiratory disease. Edwards, Charley, Keal, and Fear (1963), while comparing the effects of various treatments of acute bronchitic exacerbations, found an overall decline in the F.E.V.₁ over the 6 months' observation period of 0·07 litres, a reduction of about 5 per cent. This compares with a general rate of decline in the F.E.V.₁ of the miners examined by the Pneumoconiosis Field Research of 0·04 litres per year. The latter rate of decline varies slightly from colliery to colliery and when the men are sub-divided by age, smoking habits, and presence or absence of respiratory symptoms. In addition, Edwards and others noted a considerable variation in the F.E.V.₁ throughout the winter months and in the untreated bronchitic a fall in the F.E.V.₁ occurred which was maximal in December. Their observations are germane, for during the winter surveys reported here, the percentage of men recorded as having the respiratory symptoms complex was 18·0 per cent. at Colliery 1 and 24·5 per cent. at Colliery 2.

The mean differences found at the two collieries were unlikely to be due entirely to an "ageing" effect on the ventilatory capacity, nor as the period of examinations extended from 10·00 hours to 23·00 hours daily, were the diurnal variations described by Lewinsohn, Capel, and Smart (1960) likely to have

produced such a systematic effect. Ashford and others (1960) found that neither day of the week, time of day, nor relationship to beginning or end of shift had any effect on the measurement of ventilatory capacity. There were wide individual variations in ventilatory function but the changes appeared too great to be the result of random variation and moreover they occurred preferentially amongst the old, the smokers, and the men with respiratory symptoms. The first examination at both collieries took place during the summer months, and thus the seasonal difference might have been confused with systematic variation caused by a learning effect, but unfortunately the timing of the examinations was outside our control. In the present context, with a 6 months interval between examinations, it is considered that the effect would have been small, and that the conclusions drawn from the trials remain valid. It is possible that changes in the technique of the observer might contribute to differences in results obtained by spirometric examination on two occasions. Whilst every effort has been made to exclude such changes, the effect of the performance of an observer over a period of time is difficult to assess because of inevitable intrinsic differences in the individuals under examination. However, a measure of the standardization of the techniques can be obtained from the performance of two observers each measuring a random sample of the same population, as occurs in our routine trials. At such a trial in May, 1961, during the period of the study being reported, it was found that there was no significant difference in the mean values of the F.E.V.₁ obtained by the two observers.

The respiratory symptoms questionnaire is not a precise tool even when one questioner only is employed and, although an actual alteration in the prevalence of symptoms was thought to have occurred during the present investigation, an unknown proportion of the inconsistent replies was due to the limitations inherent in any study using a respiratory symptoms questionnaire. Nevertheless, its use is of value as shown by the relationship between the prevalence of symptoms elicited in this manner and the impairment of ventilatory capacity (Fletcher, Elmes, Fairbairn, and Wood, 1959; Fletcher and Tinker, 1961; Higgins and Cochrane, 1961; Rogan and others, 1961), and by the correspondence between replies to questions about phlegm production and the actual volume of early morning sputum. Fairbairn, Wood, and Fletcher (1959) have discussed the variability of answers to a respiratory symptoms questionnaire asked at an interval of 6 weeks. The data were obtained from examination of a sample of London Post Office workers. More than one observer

TABLE
COMPARISON OF REPLIES TO

Colliery I. June, 1960 and January, 1961

(i) Smoking Habits	January, 1961	June, 1960		
		Smokers	Non-smokers	Ex-smokers
	Smokers	559	1	7
	Non-smokers	1	90	2
	Ex-smokers	8	7	35

(ii) Consumption of Cigarettes	January, 1961	June, 1960									
		No. of cigarettes per day	0	1-5	6-10	11-20	21-30	31-40	41-50	50+	Total
	0	164	5	5	3					177	
	1-5	7	13	6	3	1				30	
	6-10	3	11	43	38	8				103	
	11-20	2	3	34	175	67	10			291	
	21-30	2		1	25	48	12	1		89	
	31-40				2	10	7			19	
	41-50							1		1	
	50+									1	
	Total	178	32	89	246	134	29	2		710	

(iii) Consumption of Pipe Tobacco	January, 1961	June, 1960								
		Oz. per wk	0	$\frac{1}{2}$	1	2	3	4	5	6 and over	Total
	0	650		4	3	1				658
	$\frac{1}{2}$									
	1	5		7	1					13
	2	1	1	4	12	3	2			23
	3				4	8				12
	4	1				1	2			4
	5									
	6 and over									
	Total	657	1	15	20	13	4			710

(iv) Consumption of All Tobacco	January, 1961	June, 1960								
		Equivalent cigarettes per day	0	1-5	6-10	11-20	21-30	31-40	41-50	50+	Total
	0	134	4	2	3					143
	1-5	2	13	10	3					28
	6-10	2	10	50	44	7				113
	11-20	2	4	35	188	68	11			308
	21-30	2		2	26	53	12	1		96
	31-40				2	12	7			21
	41-50							1		1
	50+									1
	Total	142	31	99	266	140	30	2		710

was employed, and where answers were inconsistent on the two occasions, 62 per cent. of cases were due to the failure of one of the observers to abide by the briefing instructions. Half of the remainder were due to differences in the replies of the subject and half to the difficulty of interpreting vague answers.

The briefing given to the questioner at the two

collieries placed the onus of interpreting vague answers back on to the subject being interviewed. It was thought that this procedure would produce random variations even if some accuracy was lost by denying the possibility of further explanation and probing by subsidiary questions. No alteration in technique by the observer was found after study of

IV

QUESTIONS ABOUT SMOKING HABITS

Colliery 2. June, 1962 and January, 1963

		June, 1962		
January, 1963		Smokers	Non-smokers	Ex-smokers
	Smokers	739	7	13
Non-smokers ..	3	151	10	
Ex-smokers ..	15	9	65	

		June, 1962								
January, 1963	No. of cigarettes per day	0	1-5	6-10	11-20	21-30	31-40	41-50	50+	Total
	0	289	5	4	7	2				
1-5	11	27	17	2						57
6-10	9	14	94	38	3	1				159
11-20	6	3	66	199	52	2				328
21-30			9	59	58	7	2			135
31-40	3			4	7	7	2			23
41-50						3				3
50+										
Total	318	49	190	309	122	20	4			1,012

		June, 1962								
January, 1963	Oz. per wk	0	1	2	3	4	5	6 and over	Total	
	0	921	3	5	7	1	1			938
1	5	1	11	1					7	
2	3	2	6	16	3				17	
3	2			4	10	1			27	
4	1	1		1	2	1			17	
5							2		4	
6 and over									2	
Total	932	7	22	30	16	3	2		1,012	

		June, 1962								
January, 1963	Equivalent Cigarettes per day	0	1-5	6-10	11-20	21-30	31-40	41-50	50+	Total
	0	235	5	7	5	3	1			
1-5	6	33	19	3						61
6-10	8	17	110	39	3					177
11-20	4	5	72	208	36	2	1			348
21-30			8	67	62	7	2			146
31-40				5	7	7	2			24
41-50	2					3		1		3
50+										
Total	255	60	216	327	129	19	5	1		1,012

the tape recordings of interviews, and changes in prevalence between the summer and winter surveys which were statistically significant are considered to indicate a genuine change in prevalence of symptoms on the two occasions. It is at least suggestive that, at the colliery where weather conditions were more severe at the second survey, the loss of ventilatory

capacity was more marked and the incidence of respiratory symptoms greater than at the colliery where conditions were less inclement.

The fall in ventilatory capacity and the rise in prevalence of respiratory symptoms found during the winter at these two collieries make it desirable that, where practicable, each colliery surveyed by the

Pneumoconiosis Field Research is revisited at the same time of year.

SUMMARY

At two collieries, tests of ventilatory capacity were carried out and answers obtained to a respiratory symptoms questionnaire on two occasions with a period of 6 months intervening.

The mean F.E.V.₁ showed a fall during the winter surveys at both collieries and there was also a fall in the F.V.C. at the one colliery where it was measured. The magnitude of the fall in ventilatory capacity tended to increase with increasing age and was greater among those with respiratory symptoms than amongst those without. The non-smokers showed a smaller variation than the smokers and ex-smokers. Wide individual variations were noted in both F.E.V.₁ and F.V.C.

Respiratory symptoms tended to become more prevalent during the winter surveys. Only about one-third of men examined gave consistent answers to all questions on both occasions.

There was a high degree of consistency in the classification of men in terms of smokers, non-smokers, and ex-smokers on the two occasions. A significant fall in the number of cigarettes smoked during January as compared with June was noted at both collieries.

It is concluded that the mean differences in ventilatory capacity and changes in prevalence of respiratory symptoms indicate a true fall in ventilatory capacity and a true rise in the prevalence of respiratory symptoms during the period of the January surveys, compared with the measurements obtained 6 months previously in June. It is suggested that this effect is a seasonal one.

We thank the men at the two collieries for their excellent co-operation and are grateful for the assistance we received from officials of the Board and of the Unions

in the industry. Our thanks are also due to Dr J. M. Rogan, under whose direction this work was carried out, and to our colleagues of the Pneumoconiosis Field Research for their helpful criticism and advice. Finally we wish to acknowledge the valuable work of our technical staff.

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APPENDIX

Respiratory Questionary

PREAMBLE:

"I am going to ask you some questions about your chest, about cough and spit for example. Please try and answer 'yes' or 'no'. Your answers will be treated confidentially."

COUGH		
Do you cough when you get up or first thing in the morning?	... ..	1
Do you cough like this on most days as much as 3 months in the year?	... ..	1A
Do you cough during the rest of the day? I don't mean just at the end of your shift.	... ..	2
Do you cough like this on most days for as much as 3 months in the year?	... ..	3
PHLEGM		
Do you bring up phlegm when you get up or first thing in the morning?	... ..	4
Do you bring up phlegm like this on most days for as much as 3 months in the year?	... ..	4A
Do you bring up phlegm during the rest of the day? I don't mean just at the end of your shift.	... ..	5
Do you bring up phlegm like this on most days for as much as 3 months in the year?	... ..	6
BREATHLESSNESS		
Do you have to walk slower than other people on level ground?	... ..	7
WHEEZING		
Do you ever have wheezing or whistling in your chest? I don't mean when you have a cold.	... ..	8
WEATHER		
Does the weather affect your chest?	... ..	9
SMOKING		
Do you smoke?	... ..	10
If Yes: No. of cigarettes	... ..	11
Oz. tobacco per week	... ..	12
If No: Have you smoked as much as one cigarette a day for one year?	... ..	13
CHEST ILLNESS		
In the last 3 years, have you had a chest illness that has kept you off work for more than a week?	... ..	14
If Yes: What did the doctor say it was?	... ..	15

Ex-Smokers.—All men who have smoked in the past at least one cigarette a day for one year.

Respiratory Symptom Complex is diagnosed if positive answers are given to:

- (a) Questions 3 or 6 and 7 or 8 or 9 or 14
- (b) Questions 8 and 9.