Chest symptoms in farming communities with special reference to farmer's lung

D. C. MORGAN, J. T. SMYTH, R. W. LISTER, and R. J. PETHYBRIDGE
Royal Devon and Exeter Hospital (Wonford), Exeter, and Institute of Biometry and Community Medicine, University of Exeter

J. C. GILSON, P. CALLAGHAN, and G. O. THOMAS
MRC Pneumoconiosis Unit, Llandough Hospital, Penarth, Glamorgan, Machynlleth Chest Clinic and Bronglais Hospital, Aberystwyth

Morgan, D. C., Smyth, J. T., Lister, R. W., Pethybridge, R. J., Gilson, J. C., Callaghan, P., and Thomas, G. O. (1975). *British Journal of Industrial Medicine*, 32, 228-234. **Chest symptoms in farming communities with special reference to farmer's lung.** Surveys were carried out on random samples of the farming population in Devon and Wales in order to estimate the prevalence of respiratory symptoms and of positive precipitin reactions to thermophilic fungi. Bronchitis, as defined, was common among the Welsh hill farmers, and the proportion of positive serological tests was higher in both the areas surveyed in Wales as compared with Devon. All three surveys confirmed a previous finding that the proportion of positive precipitin tests was higher among non-smokers than smokers. Although the numbers were small there was some indication that measurement of peak expiratory flow showed different relationships with age in non-smokers according to the presence or absence of positive precipitin tests. The difficulty of determining prevalence rates for farmer's lung is discussed, but the results suggest a rate not dissimilar to those found in two areas of Scotland which were more than 20 times higher than any figure previously reported in Britain.

During the winters 1970/71 and 1971/72, surveys of four representative farming populations were made. Briefly, the objectives were to determine:

- (1) the prevalence of chest symptoms within farming communities,
- (2) the prevalence of precipitin reactions to antigens associated with farmer's lung, and
- (3) the relationship between chest symptoms, chest illness, and serological reactions.

One survey carried out during 1970/71 in Devon has already been reported (Morgan *et al.*, 1973). When compared with other surveys of agricultural populations in the United Kingdom (Higgins, 1957; Higgins and Cochran, 1958) a similar prevalence of respiratory symptoms was found, although in

Devon the proportion of non-smokers was higher. Of the men examined, 29% had a positive serological reaction to *Micropolyspora faeni*, the highest proportion of positive results being found among the non-smokers. Six previously diagnosed cases of farmer's lung appeared in the sample of 188 persons who were examined.

The results of the three further surveys have been examined with particular reference to the association between positive serological tests and smoking habits, and the introduction of additional questions into the respiratory symptoms questionnaire. Peak expiratory flow (PEF) tests (Wright and McKerron, 1959) were carried out on the two later surveys (Devon 2 and Wales 2).

Material and methods

One of the three surveys was again undertaken in the same area of Devon. A random sample was obtained by extracting all patients with farming occupations from the patient lists of three general practitioners. After sorting the names into family units the heads of the households were approached. If they agreed to take part, they, together with members of their families and other workers on the farm who consented, were interviewed by one observer (RWL). Altogether 139 men and 66 women were examined, of whom 75 had taken part in the previous year's survey. One of the farmers approached declined to take part in the investigation, while one farmer's wife and one farm worker also refused. The response rate was 96%.

The farming populations living within two areas of mid-Wales were also investigated. The samples were obtained by visiting all farms known to the Ministry of Agriculture which were situated in randomly selected parishes. The 1970/71 survey in Wales was conducted among 99 people living on hill farms and the 1971/72 survey among 127 people working on the coastal plain. The response rate in Wales was 98% in 1970/71 and 97% in 1971/72. In both Devon and Wales, people examined were confined to those aged 15-65 years.

The surveys in Devon and Wales included the use of questions derived from the Medical Research Council questionnaire on respiratory symptoms (Medical Research Council, 1966). Modifications had been made to elicit the presence of attacks of breathlessness associated with fever or shivering, a history of allergy, and past illnesses other than chest illnesses. Some of the important amendments are shown in Appendix 1. A more comprehensive occupational history was also taken. The questionnaire required translation into Welsh for use in some of the examinations in Wales. Serological testing was performed by laboratories at Aberystwyth and London. Tests were classified as negative (-), very weak ($\pm$), weak (+), moderately strong ($++$), and strong ($+++$). The same Public Health Laboratory Service antigen and methods were used in both laboratories and a comparison between laboratories suggested similar reading levels.

PEF measurements were expressed as a mean of three recordings.

The totals shown in the tables are not always compatible. For some cases the questionnaires were incomplete, or the results of serological testing were not available because of damage or unsuitability of the specimen. The number so affected did not exceed two in any of the analyses.

Results

Seventy-five people had been examined on two occasions in Devon and the serological tests of 71 were available for comparison (Table 1). Fifty-five (77%) readings were the same on both occasions, eight (11%) showed an increase in the strength of a positive reaction, and eight (11%) were weaker. The prevalence of respiratory symptoms was lower during the second year.

TABLE 1
COMPARISON OF RESULTS OF SEROLOGICAL TESTS OF A POPULATION SURVEYED ON TWO OCCASIONS

Survey 1970/71	Survey 1971/72					Total
	-	$\pm$	+	++	+++	
-	48	3	2	-	1	54
+	2	3	4	2	-	11
++	-	-	2	1	-	3
+++	-	-	-	1	2	3
Total	50	6	8	4	3	71

Two persons negative first survey, not tested second survey
Two persons not tested first survey, negative second survey
Strength of precipitin reaction: - negative; $\pm$ very weak;
+ weak; ++ moderate;
+++ strong

TABLE 2
PREVALENCE OF PHLEGM PRODUCTION ON MOST DAYS FOR AT LEAST THREE MONTHS OF THE YEAR

Survey	Phlegm production	Age (Years)						Total	
		15-29		30-44		45-65			
		M	F	M	F	M	F	M	F
Devon ..	Total % Yes	36 13.9	15 0	50 8.0	25 0	52 19.2	26 0	138 13.8	66 0
Wales 1 ..	Total % Yes	10 0	4 0	16 6.3	11 0	36 33.3	20 15.0	62 21.0	35 8.6
Wales 2 ..	Total % Yes	15 0	3 0	34 5.9	15 6.7	47 19.2	13 15.4	96 11.5	31 9.7

M = male; F = female

For the three surveys the production of phlegm on most days for as much as three months in the year has been taken as a definition of chronic bronchitis. This is equivalent to grades 1 and 2 in the classification suggested by the MRC on the Aetiology of Chronic Bronchitis (1965). The number of people giving positive replies is shown in Table 2. Over the age of 45 years about 19% of men had this symptom in Devon and on the second Welsh survey. Among Welsh hill farmers surveyed in 1970/71 a prevalence of 33% was found. The number of women with this symptom is small. A summary of proportions for this and other findings is given in Table 3 where results from the 1970/71 Devon survey are also given for comparison.

The proportion of positive serological tests was higher in both areas of Wales than in Devon for both men and women (Table 4). In Devon there was a slight tendency for the proportion of positive tests

obtained in men to increase with age. No such trend was apparent in the two Welsh populations for either men or women.

As mould formation on hay is encouraged by a wet summer when hay is gathered in a damp condition, representative rainfall figures were obtained for east Devon and west Wales for the five summer months. In Devon the mean monthly rainfall for the period during 1970 was 45.6 mm, and during 1971 41.9 mm. In Wales, the corresponding figures were 59.6 mm and 65.7 mm.

Examination of the relationship between positive serology and smoking habits (Tables 3 and 5) showed that in all three surveys the proportion of positive tests was higher in the male non-smokers than the smokers. Ex-smokers were similar to non-smokers in this respect. There were few women smokers and ex-smokers so no comparison was made for them. Table 6 shows the significance of

TABLE 3
COMPARISON OF PROPORTIONS (%) DERIVED FROM RESULTS OF SEROLOGICAL TESTS AND ANSWERS
TO RESPIRATORY SYMPTOMS QUESTIONNAIRE (MEN)

	Devon		Wales	
	First Survey	Second Survey	First Survey	Second Survey
Number of men in sample	126	139	63	96
<i>Serology</i>				
Positive	28.8 (16.0) ¹	27.5 (8.7) ¹	47.6 (30.2) ¹	56.3 (30.2) ¹
<i>Smoking habits</i>				
Prevalence smokers	36.8	39.1	50.8	50.0
Smokers with +ve serology	17.4	14.8	37.5	41.7
Prevalence non-smokers	33.6	38.4	31.7	29.2
Non-smokers with +ve serology	38.1	35.8	55.0	78.6
<i>Answers to questionnaire</i>				
Cough for 3 months each year	18.4	21.7	31.7	17.7
Phlegm for 3 months each year	8.8	13.8	20.6	11.5
Period of increased cough and phlegm	3.2	5.1	12.1	30.2
Attacks of breathlessness	18.4	19.6	14.3	14.7
Attacks of breathlessness with fever or shivering	39.1	33.3	33.3	28.6
Breathing uncomfortable during or after:				
handling grain	—	21.0	—	29.2
handling hay	—	20.3	—	27.1
handling straw	—	16.7	—	15.6
Uncomfortable breathing:				
while working	—	15.2	—	20.0
shortly after work finished	—	16.7	—	34.7
hours after work finished	—	11.6	—	9.5
Short of breath walking on level	16.0	15.2	25.4	11.5
Chest sounds wheezy or whistling	26.4	21.7	22.2	26.0
Chest illness in past 3 years	9.6	8.7	23.8	26.0
Any other severe illness	17.5	23.0	19.0	27.1
Usually wears a mask during part of working day	32.0	25.4	4.8	17.7
Weather affects chest	8.8	7.3	20.6	13.5
Suffers from asthma	5.6	3.6	3.2	2.1
Suffers from hay fever	12.0	8.0	3.2	5.2

¹Moderate and strong positive

TABLE 4
PREVALENCE OF POSITIVE SEROLOGICAL RESULTS BY AGE AND SEX

Survey		Age (Years)						Total	
		15-29		30-44		45-65			
		M	F	M	F	M	F	M	F
Devon	Total % +ve	35 14.3	15 26.7	50 30.0	25 8.0	52 32.7	24 8.3	137 27.0	64 12.5
Wales 1 ..	Total % +ve	10 40.0	4 0.0	16 56.3	11 27.3	36 47.2	20 25.0	62 48.4	35 22.9
Wales 2 ..	Total % +ve	15 60.0	3 33.3	34 44.1	15 53.3	47 63.8	13 53.9	96 56.3	31 51.6

M = male; F = female

TABLE 5
RELATIONSHIP OF SEROLOGICAL RESULTS WITH SEX AND SMOKING HABITS

Survey	Serology	Sex	Smokers	Ex-smokers	Non-smokers	Total
Devon 2	Negative	Male	46	20	34	100
		Female	5	3	49	57
	Positive	Male	7, 1	6, 5	13, 6	26, 12
		Female	1, 1	0, 0	5, 1	6, 2
	Total		61	34	108	203
Wales 1	Negative	Male	20	4	9	33
		Female	6	0	21	27
	Positive	Male	7, 5	2, 5	2, 9	11, 19
		Female	0, 0	0, 0	6, 3	6, 3
	Total		38	11	50	99
Wales 2	Negative	Male	28	8	6	42
		Female	3	2	10	15
	Positive	Male	13, 7	3, 9	9, 13	25, 29
		Female	1, 0	2, 0	8, 5	11, 5
	Total		52	24	51	127

Positive results displayed as n_1 and n_2 where n_1 gives number of persons with weak positive serological results and n_2 those with moderate or strong positive results.

TABLE 6
TESTS OF DIFFERENCES IN PROPORTION OF POSITIVE SEROLOGICAL RESULTS IN TWO SMOKING CATEGORIES
MALE SMOKERS—MALE NON-SMOKERS AND EX-SMOKERS

Serology	Surveys			
	Devon 1	Devon 2	Wales 1	Wales 2
Negative against all positive tests	< 5	< 1	< 15	< 1
Negative and weak positive tests against moderate and strong positive tests	< 10	< 5	< 5	< 1

Significance levels (%) using χ^2 test

the differences in proportions for men found in the three surveys, together with those found in the survey carried out in Devon in the previous year (Morgan *et al.*, 1973). The results have been considered by dividing the serological classification at two points: negative against all positive results, and negative and weak positive against the remainder. No significant relationship was found between any of the respiratory symptoms or past illness and the results of serological tests.

On two surveys a question was asked about breathing becoming uncomfortable during or after handling grain, hay or straw (Question 9 d, e, Appendix 1). The replies from men were related to the presence or absence of attacks of breathlessness. In Devon, 17 men who reported 'uncomfortable breathing' did not have attacks of breathlessness (12.4% of all answers to these two questions). Eleven men (8.0%) who had attacks of breathlessness did not have 'uncomfortable breathing'. In Wales, 25 of the men (26.9%) who reported uncomfortable breathing did not suffer from attacks of breathlessness, but all those who did report attacks of breathlessness also found breathing uncomfortable during or after handling grain, hay or straw.

In Devon it was possible to determine from practice records whether previously known cases of farmer's lung appeared in the sample. Six were so detected and, of these, four were under treatment at the time of the survey. All six reported attacks of breathlessness and three reported that the attacks were associated with fever or shivering. Shortness of breath while hurrying on the level was reported by five of the six. Only three said that in the past three years they had had a chest illness keeping them from their usual activities for as much as a week. None of the six with farmer's lung had sputum for three months in the year, two had a wheeze, two were smokers, three were ex-smokers, and one was a non-smoker. On the basis of replies to the questionnaire and a suggestive past history, there was a consensus that a further eight cases had probably had an episode of farmer's lung. The diagnosis had been suspected in the past in four cases, and serological tests had been made. All were negative at the time. This survey was conducted within two years of the presumed diagnosis, and the four now had positive serological reactions.

In both Devon and Wales the relationship of peak expiratory flow to age and height was similar to that found in other studies (Higgins, 1957). Detailed results of the estimated relationships are given in Appendix 2. In brief, the average PEF for men was about 100 ml above the average for women. The difference was only in part attributable to differences in mean height. In general, non-smokers have estimated PEFs higher than those for smokers and ex-smokers of the same height when over the age

FIG. 1. Devon. PEF by age and smoking habits. Men, serology negative (standardized at height 1.727 m).

of 35 years. For men with negative serology, the relationships for smokers, non-smokers, and ex-smokers were statistically different (Fig. 1). There was an indication that the relationships for male non-smokers varied according to the presence or absence of positive serological tests, but the samples were too small for any firm conclusion to be drawn (Fig. 2).

FIG. 2. Devon. PEF by age and serology. Men, non-smokers (standardized at height 1.727 m).

In a comparison between Wales and Devon it can be noted that the proportion of positive serological tests was higher in both Welsh areas when compared with the area in Devon examined on two occasions. A higher prevalence of chronic bronchitis was found in the Welsh hill farms together with shortness of breath while walking on the level. In both areas of Wales the amount of past chest illness was greater than in Devon. Smoking was also commoner in Wales. The consistently increased proportion of non-smokers with positive serology in all four surveys has already been noted. Smaller numbers of

people wore protective masks in Wales and this was particularly noticeable in the Welsh hill farms.

Discussion

The prevalence of bronchitis was somewhat higher in Wales than in Devon, and the proportion of smokers was also higher in Wales. The proportion of people with positive serological reactions was higher in Wales although the number of people reporting attacks of breathlessness with or without fever was about the same in both areas. The respiratory symptoms questionnaire indicated all the known cases of farmer's lung and eight other probable cases. Some of the probable cases had negative serological reactions at the time of their presumed original attack, although these were positive up to two years later on the survey. There was a poor association between affirmative answers to what might be considered relevant questions (attacks of breathlessness with or without fever, and breathlessness related to exposure to hay) and the smaller number of probable cases indicated by records of the general practitioner. However, it is likely that a number of patients with this condition will not report their symptoms to their family doctor. The amended MRC questionnaire appeared to be helpful in detecting cases which might otherwise be missed.

An attempt was made to find some clustering of symptoms and serology within families and farms but the numbers involved were too small.

A specific effort to estimate the prevalence of farmer's lung was not among the objectives of the surveys, and no clinical definition was therefore made in advance. On the basis of moderate or strong positive results in serological testing, the prevalence rate for men ranged from 87/1000 in Devon to 302/1000 in both areas of Wales. In Devon six previously diagnosed cases were found among the sample, giving a prevalence of 43/1000. In the same area, a further eight presumptive cases could be added on the basis of present or past symptoms increasing the prevalence to 101/1000. A combination of symptoms consisting of attacks of breathlessness and uncomfortable breathing during or after handling grain, hay or straw yielded a prevalence rate of 117/1000 in Devon and 129/1000 in Wales. A further combination of these two symptoms together with moderately or strongly positive serological tests reduced these prevalence rates to 22/1000 in Devon and 54/1000 in Wales.

In spite of the ease with which the prevalence rate can be manipulated according to the standard used, it is of interest that Grant *et al.* (1972) found the prevalence of farmer's lung in two areas of Scotland to be 36 and 43 per 1000 on the basis of clinical criteria and positive precipitin tests. They noted that these were more than 20 times higher than any

figure previously reported in Britain. The figures reported for Wales and Devon are at least of the same order.

As in the first Devon survey, no clear differentiation in terms of past or present symptoms could be made between those with positive and those with negative precipitin tests. The addition of questions about the association between chest symptoms and exposure to hay did not give a clearer differentiation. At present there is no ideal way of assessing the incidence of farmer's lung and much larger populations will be required for this purpose because of the difficulty in diagnosing mild cases retrospectively. Moreover, although comparatively higher than previously thought, the incidence is still relatively low.

The finding of an increased proportion of positive serological tests among non-smokers has now been confirmed on three further populations, but the reason for this association remains obscure. No comparable association between pneumoconiosis caused by inert particles has been recorded and some direct action on the spores of *M. faeni* must be postulated. The presence of a positive precipitin test has been considered an unsatisfactory criterion for the diagnosis of farmer's lung as it may be found in the absence of respiratory symptoms. However, there was a suggestion that the PEF in non-smokers in Devon was lower in those who had positive precipitin tests. The numbers in the relevant subgroups in Wales were too small for analysis. This effect was not obvious in the smokers. The presence of one known case of farmer's lung within the non-smoking group did not produce this effect as his PEF was higher than the average for the non-smoking population.

The finding that there is some effect on the PEF in non-smokers with positive precipitin reactions is based on a small number of observations, and confirmation will require the study of larger samples.

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APPENDIX 1

(Additional questions on breathlessness supplementing MRC questionnaire)

Breathlessness

- 9a. Have you ever had attacks of breathlessness?
(If NO to 9a, go to 9d)
- b. Are/were these attacks usually accompanied by either fever or shivering?
- c. Is/was your breathing absolutely normal between attacks?

- d. Has your breathing ever become uncomfortable:
 - i—during or after handling grain?
 - ii—during or after handling hay?
 - iii—during or after handling straw?
 - iv—during or after handling any other material?
 - v—If YES to iv, specify
 (If YES to any of 9d, ask 9e.
If NO to all of 9d, ask 10)
- e. On these occasions did your breathing become uncomfortable:
 - i—while you were working?
 - ii—shortly after you finished working?
 - iii—some hours after you finished working?

APPENDIX 2

The peak expiratory flow appeared to decrease linearly with age, and increase linearly with height. The relationship

$$PEF = \beta_0 + \beta_1 \text{ Age} + \beta_2 \text{ Height} \quad (1)$$

has been estimated by least squares analysis for particular sub-groups of the survey populations. Although requiring three dimensions to show the regression planes, Figs 1 and 2 have been plotted to give PEF against age for a particular height. The relatively small numbers have precluded the exploration in depth of many sub-groups for statistical significance in terms of smoking habits and the relationship shown in equation (1).

Equation (1) can also be written in the form

$$y = \bar{y} + \beta_1 (x - \bar{x}) + \beta_2 (z - \bar{z}) \quad (2)$$

where y = PEF, x = Age, and z = Height, $\bar{y}$ = Mean PEF, $\bar{x}$ = Mean Age and $\bar{z}$ = Mean Height. Standard deviation about the regression relationship is denoted as $\hat{\sigma}$. Parameter estimates for equation (2) for some of the sub-groups of the survey populations in Devon and Wales are shown.

R^2 is the proportion of the total variation accounted for by the regression equation.

APPENDIX 2 (continued)

ESTIMATED PARAMETERS (AND STANDARD ERRORS) OF PEF AGE AND HEIGHT RELATIONSHIPS GIVEN BY EQUATION (2)

Survey	Sub-group	Number in Sub-group	Average				Parameters estimates (and standard errors)		$\hat{\sigma}$	R^2
			PEF	Age	Height (in) m		β_1	β_2		
Devon 2	Male (M)	137	497	40	68.9	1.75	-3.00 (0.63)	5.42 (2.88)	94	0.20
Devon 2	Female (F)	66	391	41	64.2	1.631	-1.54 (0.68)	13.52 (3.60)	64	0.26
Devon 2	Smokers (M)	55	487	41	69.2	1.758	-4.11 (1.06)	1.22 (4.54)	96	0.26
Devon 2	Ex-smokers (M)	31	456	48	68.1	1.73	-1.93 (1.34)	8.78 (6.14)	92	0.19
Devon 2	Non-smokers (M)	51	532	35	69.0	1.753	-1.21 (1.14)	7.68 (4.78)	91	0.08
Devon 2	Negative Sera									
	Smokers (M)	46	527	40	69.5	1.765	-4.36 (1.18)	1.91 (4.88)	99	0.28
Devon 2	Ex-smokers (M)	20	437	50	68.1	1.73	-1.22 (1.60)	-0.74 (3.44)	95	0.03
Devon 2	Non-smokers (M)	34	550	34	68.8	1.748	0.22 (1.24)	10.94 (5.07)	80	0.13
Wales 2	Male (M)	96	434	44	68.0	1.727	-3.52 (0.74)	9.29 (3.22)	92	0.30
Wales 2	Female (F)	31	330	44	63.5	1.613	-3.52 (0.79)	3.58 (4.11)	53	0.45
Wales 2	Smokers (M)	48	425	46	67.9	1.725	-4.10 (1.06)	8.20 (4.35)	90	0.33
Wales 2	Ex-smokers (M)	20	418	46	68.0	1.727	-4.15 (2.55)	11.40 (9.67)	129	0.22
Wales 2	Non-smokers (M)	28	459	39	68.0	1.727	-1.83 (1.06)	11.64 (4.90)	70	0.36