after cessation of treatment the mean figures are 8 before, 12.9 during, and 6.5 after treatment. These figures fit well with the clinical impression that, while an exceptional case treated early in the disease may show a more favourable response, all that can be expected of corticosteroid treatment is that it may suppress the progress of the disease process and certain of its symptoms, and that the favourable effects, if any, do not usually continue after cessation of treatment.

Successful treatment of these cases will probably have to await more complete knowledge of their aetiology. At present, in our study we are in the preliminary stage of collecting information and building up an accurate description of every aspect of them. To go back to a point mentioned earlier, I think that at the moment it may be obscuring important issues to call the whole of this group the Hamman-Rich disease or Hamman-Rich syndrome. If those words mean anything, they would imply that the chronic cases represented a chronic reaction to the same noxious process, whatever it may be, to which the original cases described by Hamman and Rich were an acute reaction. This may or may not be found eventually to be true; but in our present state of ignorance the use of a form of words which assumes tacitly that it is true implies the uncritical acceptance of so many unproved hypotheses that it only confuses our thought, and this should certainly be avoided. For this reason I prefer to refer to this fascinating group of cases in the chronic stage by the purely descriptive name, chronic diffuse interstitial fibrosis of the lung of undetermined aetiology.

Summary

Twenty-six cases of chronic diffuse interstitial fibrosis of the lungs have been observed during a period of nine years. Their clinical, radiological, and physiological features are described, and an account of the morbid histology, based upon studies in 13 of them, is given. The prognosis is discussed, and the effects of corticosteroid treatment in 12 cases are described.

In this lecture, which was intended to recount my own experience, I have not attempted a formal review of the extensive literature. Good reviews have been published by Grant, Hillis, and Davidson (1956) and by Rubin and Lubliner (1957). I have previously published a brief account of 12 of my cases (Scadding, 1956).

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RESPIRATORY SYMPTOMS, BRONCHITIS, AND VENTILATORY CAPACITY IN MEN

AN ANGLO-DANISH COMPARISON, WITH SPECIAL REFERENCE TO DIFFERENCES IN SMOKING HABITS

BY

H. C. OLSEN, M.D.

Rønne, Bornholm

AND

J. C. GILSON, M.B., F.R.C.P.

Director, Medical Research Council Pneumoconiosis
Research Unit, Llandough

Reid (1956) has drawn attention to the striking difference in the crude mortality rates (per million) from bronchitis in Great Britain (838) and in Denmark (33). Christensen and Wood (1958) concluded that these differences were most unlikely to be caused solely by diagnostic differences in the two countries. They suggested that, as the cigarette consumption in England and Wales was about double that in Denmark, this might be an important factor causing the difference.

Dr. A. L. Cochrane suggested that Bornholm might be a suitable place to make a direct comparison with the surveys made in South Wales and Scotland of respiratory symptoms (Higgins, 1957; Higgins and Cochran, 1958) because the island has been the centre of a number of successful epidemiological studies (Olsen, 1943; Fremming, 1951; Dencker and Felbo, 1958). In South Wales (Vale of Glamorgan) and in Scotland (Annandale) the populations were defined by private census, and a random sample of men aged 55–64 were asked to collaborate. In Bornholm one of us (H. C. O.) has for a number of years called up age-defined groups for examination as part of the programme for the control of tuberculosis, using the civil population lists. The response has been excellent, and it seemed probable that if men aged 55–64 were sampled from the town list of Rønne (where the principal tuberculosis dispensary in the island is situated) we might expect a response as good as that achieved by Dr. Higgins (over 90%).

Bornholm is an island of about 588 square km. situated in the Baltic, 200 km. off the east coast of Zealand, the largest Danish isle. It forms one of the administrative counties of Denmark and has a population of 48,959. About half the population live in the country and the remainder in the few small towns, the largest of which is Rønne, on the west coast.

Most of the population are directly or indirectly employed in agriculture or fishing, but there is an important granite industry, and a large factory making fire-bricks, glazed tiles, and drain-pipes.

Rønne has a population of 13,200; it is the commercial centre of the island and a fishing port. It is a strikingly clean and well-kept town and has no slums or visible atmospheric pollution. The average temperature in February is 32.2° F. (0.1° C.), and in July 61.4° F. (16.3° C.). This is only a little colder in winter and a little warmer in summer than the Vale of Glamorgan and Annandale. At the turn of the

seasons, in spring and autumn, there is a period when the island is frequently enveloped in cold but clean sea-fogs. The rainfall (0.5 m. per annum) is about half that in the Vale of Glamorgan and Annandale. The population density in Rønne is about 14 persons per hectare (35 per acre), but this is an underestimate of the true figures, since most of the people live within an area which is only about one-third the total within the town boundary. The population density in the Vale of Glamorgan is 0.5 per acre and in Annandale 0.1 per acre.

Procedure

The town list is kept up to date every three months, and all those residing there for three months or more must register their age, occupation, and address with the civil authorities. There is also an annual list of tax assessments of all residents which provides an index of economic status because the assessment is proportional to total income from all sources.

A list of all men aged 55–64 on April 1, 1958, was prepared from the register, and a sample of 200 chosen at random from this list. During May, 1958, the practitioners were notified of the survey, and the local press gave accounts of the intended investigation and asked for the collaboration of those who were chosen to attend. The selected men were written to a few days ahead and were asked to attend at the dispensary in the late afternoon or evening on a given day. Those who failed to attend received a personal letter by the first post the following morning, and were also contacted by telephone in many instances. The survey lasted three weeks from the beginning of June, and took place in fine weather. The two surveys in the U.K. also took place in the spring and summer.

Methods

The respiratory symptoms, past medical history, and smoking habits were recorded by one of us (H.C.O.) using essentially the same standardized questionnaire which was used by Higgins (1957) and Higgins and Cochran (1958) and which has been studied for reproducibility by Fairbairn, Wood, and Fletcher (1959) and Higgins, Cochran, Gilson, and Wood (1959) and shown to give reasonably consistent assessments of many of the symptoms. It was identical with the one now in use in the study of bronchitis by the College of General Practitioners in the U.K. The principle in its design is the recording of the main respiratory symptoms in response to standard questions—the wording of which has been modified by trial and error to remove ambiguities so far as is possible. The pattern of symptoms at different ages and in different groups can then be compared without reaching a final definition of chronic bronchitis, about which there is at present no general agreement.

Nearly all the men called up had already attended the dispensary on at least one occasion in the past, and complete records of tuberculin sensitivity and the results of x-ray examinations were available. In those in whom this information was lacking, a Mantoux test was made (10 units P.P.D.). Screening of the chest was done on all subjects by H.C.O., and films were obtained where there was any doubt about the observations.

Four physiological measurements were made by J.C.G. (1) The forced expiratory volume (F.E.V.) over 0.75 second following a maximal inspiration. This

volume was multiplied by 40 to give a measure of the breathing capacity (I.M.B.C.) (see Gandevia and Hugh-Jones, 1957, for terminology). The mean of three measurements (after rejection of the first two trials) was accepted and the volume corrected to B.T.P.S. (2) The forced vital capacity (F.V.C.). (3) The percentage change in nitrogen between 750 and 1,250 ml. on the alveolar plateau following a single breath of oxygen using the Lilly type of nitrogen meter (Comroe and Fowler, 1951). The method of calculation was simplified by making the pen recorder write on a drum mounted on the wheel of a spirometer. In this way a direct plot of nitrogen percentage against volume was obtained. The time marker was used to check that the expiratory flow rate was not excessive. The mean of three measurements was adopted. The test provides an index of the uniformity of ventilation within the lungs. (4) The peak flow during a maximal forced expiration was estimated, using the Vane type of recorder developed by Wright and McKerrow (1959). Special calibration checks on the instruments were made, so as to ascertain that no instrumental bias could account for differences obtained in this survey and those made by Higgins.

Weight (to the nearest 0.1 kg.) and height and stem height (to the nearest 0.5 cm.) were measured by Miss S. Hansen, who also acted as interpreter during the physiological tests.

The Sample

TABLE I.—*Sample of Men Aged 55–64 Living in Rønne*

Total Population April, 1958	Males Aged 55–64	No. in Sample	No. Attending	Too Ill or Away	Refused
13,200	594	200	183* (91.5%)	3	14

* 3 men left between April 1 and June 1 and were replaced by substitutes chosen at random.

TABLE II.—*Relation of Anthropometric and Physiological Measurements, and Tax Assessments to Willingness to Attend*

	No.	%	Age	Weight (kg.)	Sitting Height (cm.)	I.M.B.C. (l./min.)	Peak Flow (l./min.)	Tax Index Median
Group 1	139	69.5	58.6	80.7	87.4	107	474	1,060
" 2	25	12.5	58.9	80.8	86.7	110	505	783
" 3	19	9.5	58.6	82.3	86.7	104	461	750
Refused	14	7.0	—	—	—	—	—	450
Too ill or away	3	1.5	—	—	—	—	—	—

For definition of groups see text.

Table I shows that 91.5% of the men selected at random were examined. This is practically the same response rate as obtained by Higgins in his survey. In Table II the 183 men are divided into three groups according to their willingness to attend. Group 1—those who came in response to a first letter; group 2—those who came after a second letter and/or telephone call; and group 3—those who came only after more persuasion, including in some cases home visits. There is no trend relating weight or height or physiological results to willingness to attend, but there is to the index of tax assessment; those who refused paid on the average less in taxation than those who attended. The high proportion of men in group 1 is impressive evidence of the interest shown in the survey. We conclude that the sample examined was probably representative of the whole, and can with reasonable confidence be compared with the samples seen by Higgins. Out of the 183 who attended, 160 had been examined previously at the dispensary as part of the tuberculosis control in

the island. 23 men attended for the first time. Of the lapses, six had previously been seen at the dispensary.

Prevalence of Respiratory Symptoms

In both areas studied by Higgins there were a few men with mining and quarrying experience. These men were found to have more symptoms and a lower ventilatory capacity, and so were omitted in his strict comparison of agricultural workers between the two areas. To make our comparison as strict as possible we have done the same and removed 27 men who had worked one or more years in quarries. Table III shows for

TABLE III.—Prevalence of Respiratory Symptoms in Random Sample of Men Aged 55-64 in Bornholm, Wales, and Scotland

Symptom	Annandale	Vale of Glamorgan	Rønne	Significance
No. in sample	87	86	156	
Cough	25 (28.7)	27 (31.4)	27 (17.3)	<0.05
Sputum	20 (23.0)	24 (27.9)	17 (10.8)	<0.01
Cough and sputum	17 (19.5)	22 (25.6)	14 (9.0)	<0.01
Wheeze	38 (43.7)	41 (47.7)	24 (15.4)	<0.01
Haemoptysis	5 (5.7)	7 (8.1)	0 (0)	<0.01
Weather affecting chest	9 (10.3)	10 (11.6)	15 (9.6)	N.S.
Chest illness in previous 3 years with cough and sputum	16 (18.3)	14 (16.3)	10 (6.4)	<0.01
1	12 (13.8)	10 (11.6)	10 (6.4)	N.S.
2 and more	4 (4.6)	4 (4.7)	0 (0)	
Past illness:				
Pneumonia	21 (24.1)	16 (18.3)	30 (19.2)	N.S.
Pleurisy	7 (8.0)	9 (10.5)	10 (6.4)	
Bronchitis	13 (14.9)	20 (23.3)	26 (16.7)	
Asthma	5 (5.7)	5 (5.8)	3 (1.9)	
"Chronic bronchitis"	6 (6.9)	5 (5.8)	4 (2.6)	

The questionnaires and tables of symptoms in detail can be obtained from the Pneumoconiosis Research Unit. "Chronic bronchitis" is defined as those with persistent sputum and at least one chest illness in the previous three years. The significance test in each case was a χ^2 with 2 degrees of freedom. Percentages are shown in parentheses.

the three surveys the absolute numbers and percentage prevalence of those symptoms which are most reproducibly assessed. The striking similarity of prevalence in Annandale and the Vale of Glamorgan has already been commented on by Higgins and Cochran (1958). We now see the prevalence is much lower among the men in Rønne, about half or less. A feature is the absence in Rønne of any men with more than one chest illness with increased cough and sputum in the previous three years. The proportion reporting that the weather affected their chest is similar in all areas.

It is also of interest that the percentage reporting attacks of pneumonia, pleurisy, or bronchitis in their past history is also similar in all areas. Asthma was reported less often in Rønne, but the difference is not statistically significant. The proportion with "chronic bronchitis," when arbitrarily defined as those with persistent sputum and a chest illness in the previous three years, is very similar in Annandale and the Vale of Glamorgan, but only about half as frequent in Rønne. However, the number of cases is small and the difference not statistically significant. The significant differences in the prevalence of the common symptoms between Rønne and the two U.K. samples could be due to a

large bias in the recording between the two observers concerned. We have no direct evidence on this point, which must inevitably be in doubt to some extent in such international comparisons on account of the language difficulties. The similarity of the prevalence of past illnesses in all three areas makes it seem unlikely that there is a big bias in recording, and the findings confirm the impression one of us got during the survey of the small proportion who coughed or produced any wheezing during the physiological measurements.

Table IV summarizes the clinical grading of the degree of breathlessness using a scheme based on that suggested by Fletcher (1952). Grade 2 and over are all those who replied "yes" to the question, "Do you have to walk slower than other people of your own age on the level because of breathlessness?" Grade 3 are those who replied "yes" to the question, "Do you ever have to stop for breath when walking at your own pace on the level?"

The proportion in the two groups is similar in the U.K. samples, and again about one-half in Rønne, but the differences are nearly statistically significant ($P=0.062$).

Fletcher *et al.* (1959) have recently published the prevalence of respiratory symptoms of a sample of London Post Office workers using the same questionnaire. Table XII (in the Appendix) shows a comparison of the men in London aged 50-59 and those in Rønne aged 55-64. There is a much higher prevalence of symptoms in the Post Office workers, especially in the more severe symptoms such as "persistent cough and sputum throughout the day," and also in the frequency of chest illnesses.

Anthropometry

Table IV shows that there is little difference in average height between men in Rønne and Annandale, but the men in the South Wales sample are 4 cm. (1.58 in.) shorter. The sitting height, which is more closely related to lung function than total height, was only about 1 cm. less in the men in Rønne than in the two other groups. The differences in stem height between the groups are too small to have affected materially the physiological findings. The men in Rønne were on the average 10 kg. (22 lb.) heavier than men in the other two areas.

Ventilatory Capacity

The I.M.B.C. was on the average 11 l./min. (12%) higher in Rønne than in Annandale, and 17 l./min. (19%) higher than in the Vale of Glamorgan. The difference between Rønne and the other two areas is statistically significant at the 0.001 level.

The differences between Rønne and the other two samples cannot be accounted for by differences in the size or weight of the men. Studies of observer bias in recording the F.E.V. between Higgins and J.C.G.

TABLE IV.—Anthropometry, Ventilatory Capacity, and Clinical Grades of Dyspnoea in Samples of Men Aged 55-64 in the Three Areas (Excluding Miners and Quarrymen) (Means)

Area	No. in Sample	Height (cm.)	Sitting Height (cm.)	Weight (kg.)	I.M.B.C. (l./min.)	Peak Flow (l./min.)	N ₂ % Change	Clinical Grade	
								2 and Above	3 and Above
Rønne	156	171.0	87.2	80.4	106.3*	470†	1.66	25 (16%)	7 (4.5%)
Annandale	87	170.9	88.6	72.1	95.1	441	—	25 (28.7%)	8 (9.2%)
Vale of Glamorgan	86	166.9	88.1	69.1	89.1	494	—	21 (24.4%)	7 (7.9%)

* Difference between Rønne and Annandale or Vale of Glamorgan is significant at 0.001 level. Annandale and Vale not significantly different.

† Difference between Annandale and Vale of Glamorgan is significant at 0.02 level. Rønne not significantly different from either.

(Higgins *et al.*, 1959) have failed to demonstrate statistically significant differences, and it is unlikely that out of the 17-l. difference more than 3 l. could have arisen on account of differences in the observers.

The peak flow (l./min.) usually correlates highly with the I.M.B.C. (r = approximately 0.8; Wright and McKerrrow, 1959), so we might have expected this test to assess the areas in the same order as the M.B.C. Table IV shows that this is not so: the men in Rønne lie between those in Scotland and South Wales, and the latter two are reversed in order as compared with the M.B.C. The cause of this is unlikely to be instrumental. Nor is it likely to be due to a larger random error in recording the peak flow, because the ratio of instrumental and subject errors (standard error of the mean of three readings on a subject to the standard deviation of the mean within the population) is similar for peak flow and F.E.V. But Fletcher (personal communication) has shown that different observers do get significantly different values with the peak-flow meter. The reading depends more on the force (and hence co-operation) put into the effort of blowing than is the case with the F.E.V. (McDermott and McKerrrow, 1956). We think the apparently anomalous results are likely to be due to small differences in the co-operation achieved when doing the test, and this could produce a bias between one group and another.

TABLE V.—Frequency Distribution of I.M.B.C. and F.E.V. in Men Aged 55–64 in Rønne and Annandale (Excluding Quarry Workers)

I.M.B.C. (l./min.)	F.E.V. _{0.75} (l.)	Rønne		Annandale	
		No.	%	No.	%
10–	0.25	—	—	1	1.1
20–	0.5	1	0.6	—	—
30–	0.75	1	0.6	3	3.5
40–	1.0	1	0.6	1	1.1
50–	1.25	2	1.2	2	2.3
60–	1.5	7	4.5	6	6.9
70–	1.75	4	2.6	12	13.8
80–	2.0	22	14.1	5	5.7
90–	2.25	21	13.5	16	18.4
100–	2.5	32	20.5	15	17.2
110–	2.75	14	9.0	11	12.6
120–	3.0	23	14.7	10	11.5
130–	3.25	14	9.0	2	2.3
140–	3.5	9	5.8	1	1.1
150–	3.75	2	1.2	1	1.1
160–	4.0	3	1.9	1	1.1
Total ..		156	99.8	87	99.9

Table V shows the frequency distribution of I.M.B.C. (and F.E.V._{0.75}) in Rønne and Annandale, excluding quarry workers. It shows that only 2% of men had a value less than 50 l./min. in Rønne, compared with 6% in the Annandale sample, which is the most "healthy" population sample yet reported in U.K.

The nitrogen meter was not used in the surveys in the Vale of Glamorgan and in Annandale, and so no comparisons are available for the distribution of the

TABLE VI.—Frequency Distribution of Nitrogen Rise in the Alveolar Plateau in Men Aged 55–64 in Rønne (Excluding Quarry Workers)

N ₂ %	No.	%	N ₂ %	No.	%
0.0–	2	1.3	4.5–	1	0.6
0.5–	37	23.7	5.0–	2	1.3
1.0–	37	23.7	5.5–	0	—
1.5–	43	27.6	6.0–	0	—
2.0–	14	9.0	6.5–	0	—
2.5–	7	4.5	7.0–	0	—
3.0–	6	3.9	7.5–	1	0.6
3.5–	4	2.6			
4.0–	2	1.3	Total	156	100.0

rise in percentage of nitrogen on the alveolar plateau, shown for Rønne in Table VI. The distribution is skew; in fact, close to log normal. The mean is 1.7%, and a quarter of the subjects have a N₂% less than 1, whereas only 15% exceed 2.5 N₂%; 6.5% have a change of nitrogen of 3.5% and above. Below is shown a scatter diagram relating the I.M.B.C. to the change in nitrogen percentage. The three men who had an I.M.B.C.

Scattergram showing relation of indirect maximum breathing capacity and nitrogen clearance from lung after a single breath of oxygen.

of 50 l. and below have a change of nitrogen exceeding 3.5%, but there are 10 men who had a change of nitrogen percentage of 3.5 or more who had comparatively high values of M.B.C. though only one of them was above the mean. By using the M.B.C. only, we are clearly missing some people who may be considered to have a ventilatory defect in the sense that they show evidence of marked inequality of ventilation.

Men with Quarrying Experience

For the reasons given we omitted the men with quarrying experience in Rønne when making the strict comparisons with the U.K. sample, but Table VII shows

TABLE VII.—Anthropometry, Ventilatory Capacity, and Respiratory Symptoms of the 27* Men Aged 55–64 Doing One or More Years' Quarrying Work in Rønne

Height (cm.)	Sitting Height (cm.)	Weight (kg.)	I.M.B.C. (l./min.)	P.F. (l./min.)	N ₂ %	Tax
172	87.5	84	112	518	1.63	845
	Cough	Sputum	Cough and Sputum	Wheeze	Weather Affecting Chest	Total Chest Illnesses Last 3 Yrs.
No. %	6 22	7 26	6 22	6 22	3 11	2 7
						1 3.5

* Including two men with pneumoconiosis category 1.

that in Rønne these quarrymen did not differ strikingly from the remainder of the sample in respect of ventilatory capacity or anthropometry. Their M.B.C. at 112 l./min. was slightly higher than the average for the whole group. The percentage prevalence of sputum, cough and sputum, and wheeze was higher than in the remainder of the group, but there are too few men in

the group for any firm conclusions to be drawn about the prevalence of symptoms.

We think, therefore, we have demonstrated that there is a lower prevalence of respiratory symptoms and a higher average ventilatory capacity in men in Rønne than in those living in the agricultural areas of the Vale of Glamorgan and in Annandale. What is the explanation of this difference?

Possible Causes for the Difference between Danish and U.K. Samples

Atmospheric Pollution

Atmospheric pollution is strikingly absent from all areas and the climatic differences are not large. It seems most improbable that the differences observed could be directly related to general air pollution. Also, the proportion of subjects reporting that the weather affected their chest was the same in all areas.

Social and Economic Factors

Higgins and Cochran (1958) observed that when comparing the urban and rural communities the higher prevalence of symptoms might have been associated with the higher population density in the urban area. However, as this density in Rønne is much higher than in the two agricultural areas in the U.K., population density cannot explain the differences. The men in Rønne are much heavier than those in the other two areas, but as they are about the same height it seems reasonable to conclude that they probably eat more. They now have a diet which is probably rich in carbohydrate and fat (butter). We do not know how such a dietary difference (if it exists) could beneficially affect their chests to the extent observed. The men in Rønne have undoubtedly enjoyed a high standard of living over many years, and this may in some ill-defined way benefit their chests. It is possible that the relative isolation of the island has protected them to some extent from epidemics of upper respiratory infection, but as there is a daily boat to and from the mainland the isolation is by no means complete.

Smoking

Higgins (1959) studied the effect of smoking on respiratory symptoms and ventilatory capacity in five random samples of men of this age-group. He found a striking difference between the smokers and non-smokers, and also a trend of increasing symptoms and reduced ventilatory capacity within those who smoke. Table VIII compares the smoking pattern of the men in Rønne and in the five samples from the U.K. The percentage of non-smokers in Rønne (15.9) is double that in the U.K. The proportion of ex-smokers is the same in all samples. The Table also shows that among those who smoke there is a tendency to smoke less in Rønne than in the U.K. In Rønne 64.1% of the

smokers smoked less than 15 g. a day, whereas in the U.K. samples this figure was 55.9%.

In the U.K. sample the majority of smokers (82%) smoked cigarettes alone or combined with pipes. Only about 20% smoked pipes alone. The situation is very different in Bornholm, where, out of the 128 smokers, only 40 (31%) smoked cigarettes at all; 14.1% were purely cigarette smokers; 15.7% smoked pipes only; and 25.8% cigars alone.

The relatively high proportion of pure cigarette, cigar, and pipe smokers enables a comparison of the effects of taking tobacco in these three ways to be made. Table IX shows this comparison for men smoking 5 g. and more tobacco a day. The average M.B.C. of the 13 purely cigarette smokers was 91 l./min., compared with 113 for the pipe smokers and 117 for the cigar smokers. The difference of over 25 l./min. between the cigarette smokers and the cigar smokers is statistically significant ($0.05 > P > 0.02$), as is the difference between the cigarette smokers and the pipe smokers ($0.02 > P > 0.01$). The average I.M.B.C. of the cigarette smokers differs significantly ($P > 0.01$) from the other

TABLE IX.—Comparison of Non-smokers and Those Who Smoke Only Cigars, Pipes, or Cigarettes (5 g. and Over of Tobacco Per Day)

	No.	I.M.B.C. (l./min.)	Peak Flow (l./min.)	N ₂ %	Tax Index	F.E.V. _{0.75} × 100 F.V.C.	Average Weight Smoked (g./Day)
Non-smokers	29	106.2	476	1.57	790*	70.0	—
Cigars only	18	116.6	500	1.44	2,340	73.0	14.9
Pipes only	15	112.6	453	1.49	872	69.3	12.9
Cigarettes only	13	91.1	420	2.65	1,810	67.0	12.1

* Based on 26.

I.M.B.C.: Cigar v. cigarette, $0.05 > P > 0.02$ (other differences N.S.). Pipe v. cigarette, $0.02 > P > 0.01$.
Peak flow: N.S.
Nitrogen % (using log N₂): Cigar v. cigarette, $0.05 > P > 0.02$.
F.E.V._{0.75}/F.V.C. %: N.S.

three groups (mean 110.8 l./min.), which do not differ significantly from each other. It will be seen that the average for the cigar and pipe smokers is in fact above that of the non-smokers.

The mean nitrogen percentage change is 2.65 for the cigarette smokers, and 1.44 and 1.49 respectively for the cigar and pipe smokers. The difference between the cigar and cigarette smokers is significant when using a log scale (in view of its skew distribution) for calculation of the nitrogen percentage.

The average tax paid by the cigarette smokers and cigar smokers was not very different, whereas the pipe smokers and the non-smokers paid only about half as much. The average weight of tobacco smoked was 14.9 g. a day for the cigar smokers and 12.1 for the cigarette smokers. The average values for the peak flow and the F.E.V. %/F.V.C. show a similar trend

TABLE VIII.—Smoking Pattern (g./day) of Men Aged 55–64 in Rønne (Quarrymen Included) and in Five Random Samples in U.K.

	Total Sample	Smokers						Ex-smokers	Non-smokers
		No.	1–4 g.	5–14 g.	15–24 g.	25–49 g.	50+ g.		
Rønne	183	128 (69.9)	29 (22.6)	53 (41.4)	35 (27.3)	11 (8.6)		26 (14.2)	29 (15.9)
U.K.	971	773 (79.6)	43 (5.6)	389 (50.3)	251 (32.5)	89 (11.5)	1 (0.1)	126 (13.0)	72 (7.4)

Percentages are shown in parentheses.

between the cigar and cigarette smokers, with the pipe smokers intermediate, but the differences are not statistically significant. It is interesting that the non-smokers have a lower average I.M.B.C. than the cigar smokers. This may be partly socio-economic in view of the lower average tax index, though there is no clear relation between the I.M.B.C. and the tax index in the whole group.

Non-smokers

In view of the relation between smoking and ventilatory capacity we have in Table X compared non-smokers in the two U.K. samples and in Bornholm, both for

TABLE X.—*Non-smokers. Excluding Quarryworkers and Miners*

Sample	No.	I.M.B.C. (l./min.)	Cough	Sputum	Wheeze	Chest Illnesses		Grade 2+
						1	2+	
Rønne	24	108	2 (8%)	2 (8%)	2 (8%)	4 (16%)*	0	4 (16%)
2 U.K.	11	108	0	0	0	0	0	0

* Two chest illnesses were pneumonia and hypertensive heart failure.

respiratory symptoms and M.B.C., using only men who have not worked in the quarries or mines. The numbers are very small in such "pure" groups. The average M.B.C. in Rønne and the two U.K. samples together, is the same (108 l./min.). None of the 11 men in the U.K. samples had respiratory symptoms, chest illnesses, or complaint of breathlessness. In the 24 men in Rønne the prevalence of symptoms is less than in the whole sample (Table III), but higher than in the U.K. samples. This is the only comparison where the general trend of differences between Rønne and the U.K. disappears or reverses, and perhaps suggests that the differences between Rønne and the U.K. are largely the result of differences in smoking habits.

Examination for Tuberculosis

Table XI shows the results of the study of tuberculin sensitivity. 78% of the sample seen were naturally Mantoux-positive, and a further 10% were positive as a result of previous B.C.G. vaccination. Eight of the men

TABLE XI.—*Mantoux Tests*

	Negative	Natural Positive	B.C.G. Positive	Total	Not Examined
No. ...	22 (12%)	143 (78%)	18 (10%)	183	17

who were negative were vaccinated with B.C.G. in accordance with the policy pursued in Bornholm (Olsen, 1943).

No clinically significant cases of tuberculosis were revealed during x-ray screening. Two cases of category 1 silicosis which were already known were included among 27 quarrymen whose names appeared in the sample.

Discussion

Our comparative study of representative samples of the population of males aged 55–64 in Rønne and in two agricultural areas in the U.K. has demonstrated a lower prevalence of respiratory symptoms (but not of past chest illness) in Rønne. The higher average I.M.B.C. in Rønne supports the conclusion that there is a real difference in the prevalence of non-specific

chronic chest disease in the two countries. Differences in height, weight, and population density cannot account for the findings, while atmospheric pollution is minimal in all three areas.

Tobacco smoking is, however, a possible explanation; there are more non-smokers in Rønne, and those who smoke tend to smoke less than in the U.K., with a striking difference in the proportion of men smoking cigarettes—over 80% in the U.K., only about 30% in Rønne in this age-group. Looked at in another way, men of this age in Rønne smoke only 780 cigarettes per head per annum compared with 3,400 smoked in the U.K.

The percentage of non-smokers (15%) observed in Rønne is rather lower than the 25% reported for men of the same age in the Danish National Morbidity Survey of 1950 (Hamtoft and Lindhardt, 1955), and is possibly attributable to our stricter definition of non-smokers. The relatively small proportion of cigarette smokers compared with pipe and cigar smokers we found is in accord with their findings.

A feature of the group seen in Rønne is that no man had more than a single chest illness with increased sputum in the previous three years; thus recurrent bronchitis, which is so common in some of the other groups studied in the U.K., was absent. In the period 1951–6 inclusive only 16 deaths from bronchitis were recorded in Bornholm for all ages in both sexes—a crude death rate of 4.8 per 100,000 per annum, which is in line with the general figure for Denmark.

Two of the physiological tests, the I.M.B.C. and the nitrogen curve following a breath of oxygen, indicate that those who smoke only cigarettes have more impairment of lung function than those who smoke only cigars, despite both groups smoking a similar weight of tobacco per week, and having a similar economic status as judged by their annual tax assessment. The number of subjects in these "pure" groups of two types of smoking is small, and the comparison should, we think, be made in larger samples and in other countries where there are enough cigar and cigarette smokers.

Franklin (1958) has reported that smokers show impairment of the mechanics of breathing compared with non-smokers. Eich *et al.* (1957) and Attinger *et al.* (1958) reported that a single cigarette increased the pulmonary airway's resistance in subjects with chronic obstructive emphysema but not in normal subjects. Our results suggest that it would be worth while to extend such studies to the acute effects of cigars and pipes. It may be that there are important differences in the pharmacological action on the lung of different kinds of smoking. Cigar smoke is reported to be alkaline, whereas that from cigarettes is usually acid (Cook, 1957).

The severity of the bronchial irritation may be a factor of importance in the aetiology of lung cancer (Burnet, 1958). Case and Lea (1955) showed that a history of bronchitis is related to subsequent development of lung cancer. Doll and Hill (1956) and Hammond and Horn (1958) found that the risk of lung cancer is higher in cigarette smokers than in pipe or cigar smokers. In our survey the tests of lung function place the types of smoking in the same order. The cigarette smokers were most affected, the cigar smokers least, with the pipe smokers intermediate. These tests of ventilatory capacity and gas distribution are likely

to be a rough measure of the severity of bronchial irritation because they are influenced by inflammation, oedema, and secretions in the bronchial tree. If the risk of developing lung cancer is determined both by the severity of the chronic bronchial irritation and by the presence of carcinogens in the smoke, Wynder's (1959) finding of similar carcinogenic activity in the tars of cigarette, pipe, and cigar combustion is understandable. We would expect the severity of the bronchial irritation to be dependent on many factors, such as the way the tobacco is smoked and characteristics of the smoke not closely related to the carcinogenic activity of the tars.

A better understanding of the factors influencing the severity of bronchial irritation produced by different types of smoking and different tobaccos would be of help in the prevention of bronchitis and perhaps lung cancer in those who smoke.

Reid (1958) has emphasized the relation of atmospheric pollution to bronchitis. Higgins *et al.* (1956, 1959) have shown the importance of mining and smoking as a cause of increased respiratory symptoms and reduced ventilatory capacity. Thus the very low prevalence of non-specific chronic respiratory disease in Rønne is likely to be the result of a number of favourable factors operating together.

This international epidemiological comparison has shown the need to standardize for both the amount smoked and the type of smoking when studying chronic non-specific respiratory disease, and indeed when attempting to define normal lung function. It has also demonstrated the practicability, in favourable circumstances, of such international epidemiological studies without the use of a large team of investigators.

Summary

Representative samples of men aged 55–64 in Rønne (Bornholm) and two agricultural areas in the U.K. are compared for prevalence of respiratory symptoms and ventilatory capacity.

The prevalence of symptoms is significantly lower in Rønne. The mean indirect maximum breathing capacity (I.M.B.C.) is significantly higher in Rønne (106 l./min.) than in the U.K. samples (92 l./min.). The differences are not explicable on the basis of differences in height, weight, density of population, or atmospheric pollution.

There are more non-smokers in Rønne and many fewer cigarette smokers than in the U.K. samples. Only in the small group of non-smokers are there no physiological or clinical differences between Rønne and the U.K. sample. In Rønne there was a significantly lower I.M.B.C. and poorer single-breath nitrogen clearance in the pure cigarette smokers than in the cigar smokers—despite similar tobacco consumptions.

The results are discussed in relation to the problem of bronchitis and lung cancer. The practicability of international comparisons of this type, using standardized criteria and tests, are demonstrated.

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APPENDIX

TABLE XII.—% Frequency of Symptoms in Total Rønne Sample Compared With Those of Post Office Workers in London

Question	Rønne Aged 55–64	Post Office Workers Aged 50–59
1: Cough, usually	18	37
2: Cough on rising, winter	16	54
3: " " " " summer	2	39
2+4: Cough all day, winter	1	20
2+5: " " " " summer	0	11.5
6: Phlegm usually	13	47
7: " " on rising, winter	11	47
8: " " " " summer	10	32
7+9: Phlegm all day, winter	1	25
7+10: " " " " summer	0	13.5
*17: Dyspnoea grade 1 (no dyspnoea)	73	64
" " " " 2	11	20
" " " " 3	15	14
" " " " grades 4 and 5	0.5	2
22: Wheeze occasionally	16	50
23: " " " " most days or nights	0.5	20
29: Colds usually go to chest	15	37
31: Chest affected by weather	10	41
43+43a: Chest illnesses: †only 1	7	15
" " " " †2 or more	0	25

* The wording of the questions was not identical in the two surveys. This may in part account for differences in proportion in each grade.

† Excluding illnesses stated to be less than 1 week in duration.

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There are still many patients who die of cancer without ever being in hospital, according to the 1958 Annual Report of the South Western Regional Cancer Records Bureau (Director, Mr. R. M. Vick). In 1958 the number of such patients recorded in the Bureau's area was 1,786. The Report also states that the Bureau was asked to find out how many cases of leukaemia occurred among patients who had throughout the years been treated for cancer of the cervix; in 2,250 such cases only 1 case of leukaemia was recorded.