RHEUMATISM IN MINERS

PART II: X-RAY STUDY

BY

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In a field survey of rheumatic complaints Lawrence and Aitken-Swan (1952) found that coal miners suffered more disability from pain in the back sciatic distribution and in the knees than the surrounding general population, and from the limited examination possible in the field it appeared that these disabilities were due to disc degeneration, osteo-arthritis, and rheumatic disorders of undetermined nature. To investigate this more fully it was decided to carry out a detailed clinical study and a radiological survey of small but carefully selected groups of coal miners and other workers from the populations covered most comprehensively by the field survey: that is to say, the underground workers at Bedford Colliery and the employees of the engineering yard and the administrative offices at Walkden.

The study was confined to males in the fifth decade. This age group was chosen as most likely to show the effects of occupation upon the incidence and severity of degenerative joint changes, since at this age these changes begin to be radiologically demonstrable in a proportion of the general population. Consideration of the numbers available between the ages of 40 and 50 showed that there were 47 office workers (clerks and administrative staff), 89 manual workers (blacksmiths, machinists, carpenters, painters, and general labourers), and 259 miners. We decided to study all 47 office workers together with an equal number of manual workers, thus making a composite group of 94 non-miners who had never been underground, and to compare these with 94 underground workers. All manual and underground workers in the appropriate age group were therefore numbered consecutively and the samples for study were abstracted by random sampling of numbers. To avoid error due to increasing observer experience each of the three groups of workers was evenly distributed throughout the study; thus five office

workers were seen at one session, five manual workers at the next, and five miners at the third and fourth, and so in sequence thereafter. This also secured complete impartiality on the part of those reading the radiographs to whom the order of calling was unknown.

In spite of difficulties due to the long distance some of the miners had to travel to the clinic, there were only nine refusals amongst the miners and five amongst the non-miners. From the field survey it was known that three of the miners and two of the non-miners who refused had in fact suffered from rheumatic complaints so that these refusals did not appear to be associated with the presence or absence of complaints. In addition a number of men had left their employment and could not be traced, so that the groups finally studied were 84 miners, 45 manual workers, and 42 office workers. In addition 24 men who had worked both underground and on the surface were investigated, and the findings in these men have been included in those tables which do not deal with comparisons between miners, manual, and office workers.

Method of Examination

A detailed history was taken of both rheumatic and other symptoms and of past and family illnesses. Then a routine general clinical examination was carried out, a note being made of all deviations from the normal regardless of whether or not they were causing disability. Particular attention was naturally paid to the limb joints and the spine. In addition, height, stem height (from the seat to the top of the head in a sitting position), and body weight were recorded. The x-ray examination included lateral views of the cervical and lumbar spine in both flexion and extension, an antero-posterior view of the lumbar spine, and a lateral cone picture of the lumbo-sacral junction. In

addition A.P. and lateral views of the right knee and an A.P. view of the right hand were taken, together with any other joints that the clinical examination suggested were abnormal.

A rough clinical assessment of the mental health was made in three grades and each man was also subjected to a series of psychometric tests designed to assess "emotional stability".*

Results of Clinical Examination

Rather more rheumatic complaints were noted in the clinic study than in the field survey which had been carried out two years previously. The additional complaints consisted of 11 conditions which had appeared since the survey, and 15 old complaints which had not previously been mentioned. On the other hand only one man failed to mention a previously recorded complaint. Other symptoms, such as dyspepsia, headache, cough, dyspnoea, were less frequent than rheumatic complaints but the men knew that the study was mainly one of rheumatic disorders. Apart from rheumatic complaints there was little difference between the symptoms found in the three groups except that a complaint of cough was made by 23 miners as against only one manual worker and four office workers.

Examination of the spine and limbs revealed many minor deviations from the normal such as slight deformity, more or less painful limitation of movement, joint crepitus, and small synovial effusions. The significance of many of these findings was difficult to assess, and we will therefore only mention some of them briefly. At the time of

present in six men, all of whom were miners; some abnormality of the knees was found in a further 35 men, but in only six miners, three manual workers, and one office worker were these of sufficient severity to warrant a clinical diagnosis of arthritis. Signs of arthritis of the hip were found in only three men, all of whom were miners. Limitation of movement at the elbow was found in 15 men, of whom 12 were miners, and in five of these miners the signs were severe enough to warrant a clinical diagnosis of arthritis. On the other hand signs in the shoulders, such as painful limitation of movement or a painful arc in abduction, were noted in only ten men and only four of these were miners, three being office workers and three manual workers; limitation of movement at the wrist was noted in only nine men, of whom four were manual workers, two office workers, and only three were miners. Altogether signs in the lumbar spine and knees, hips, and elbows were found predominantly in the miners, but signs in the wrists and shoulders were, if anything, more common in the other groups. The general medical examination did not reveal any striking differences between the three groups studied, but minor signs in the lungs were found in ten miners as opposed to one manual and four office workers, and psychogenic disorders were noted in ten miners, but only in two manual and three office workers.

Reading of Radiographs

When reading the films the findings were recorded in a standard manner upon a specially designed form, as shown below:—

Name	No.	Bone Texture	Region	Spine									Hand	Knee	Others
				Affected Discs	Severity	Spacing	Lipping	Sclerosis	Erosion	Movement	Facets	Cong. Changes			
Smith	1	0	Cervical	4	4	2	4	4	4	2—	0	0	O.A. 1st CMC Grade 1	O.A. Grade 3	0
			Lumbar	3	2	0	3	3	3	1+	0	0			

examination 11 men had a painful disability of the back and amongst these there was only one manual and one office worker, the remainder being miners. A more common finding in the back was a loss of lumbar lordosis together with painless limitation of extension. This was found in 33 miners, nine manual and nine office workers, but limitation of straight leg raising was only noted in eight men, of whom five were miners. Symptoms and signs suggesting internal derangement of the knee were

Cervical and lumbar disc changes were graded according to the number of discs affected and the severity of the changes. The severity was assessed originally in one of five grades, (0) no abnormality detected, (1) doubtful changes, (2) minimal, (3) moderate, and (4) severe. In the text the doubtful and minimal grades have been grouped together as "slight", and the moderate and severe as "severe". Samples of these grades are shown in Figs. 1 to 4. Individual changes, such as disc spacing and lipping, were assessed only according to the number of discs affected. A disc was considered to be narrowed if it was out of sequence with those above

* These included a persistence test, a finger dexterity test, a medical questionnaire, a word connexion test, and an annoyances inventory.

FIG. 1

FIG. 1.—Lateral radiograph of lumbar spine showing signs of slight disc degeneration.

FIG. 2A

FIG. 2A.—Lumbar spine showing signs of severe degeneration of many discs.

FIG. 2B.—Severe degeneration at lumbo-sacral disc.

and below. The term "erosion" was used to denote a "rubbed off" appearance at the anterior or lateral margins of the vertebral plates. Movements were assessed as either diminished, increased, or normal; this was done by comparison with the discs above and below. In certain of those with increased movement a qualitative difference was noted, the movement being of a gliding character. Congenital changes noted included unilateral sacralization of the fifth lumbar vertebra, tropism (asymmetry of orientation of the articular facets), spina bifida, and spondylolisthesis. Spondylolysis as such was not observed in this series but special views to demonstrate it were not taken.

In the hands comparison of bone density was made with the help of a standard finger.* Changes in bone structure were also noted and osteoarthritic changes graded in five categories as in the case of the spine. In the knees similarly osteo-arthritis, if present, was placed into one of five grades (Figs. 5 and 6). In a proportion of the radiographs ossification was found in the quadriceps insertion at the upper border of the patella (Fig. 7). Other abnormalities such as old fracture, bone disease, and deformities were also noted.

All films were read by four observers and many films were read two or three times on different occasions. The variations of interpretation between different observers are given in the appendix, and a more detailed analysis is in progress, but variation in interpretation of the films does not appear to be a

* This was prepared by Dr. J. G. Ball at the Rheumatism Research Unit of Manchester University.

FIG. 2B

serious source of error in this field, and we have therefore selected the results of the first reading of the films by the most senior observer (J.H.K.) for analysis in this paper.

Radiological Findings

The changes considered under disc degeneration are those defined by Friberg and Hirsch (1949) and Schmorl and Junghanns (1951). In this condition the affected disc is narrowed and the adjacent vertebral plates are sclerosed. Movement at the disc is generally diminished though at an early stage it may be increased and of an abnormal gliding character. In addition there is usually some anterior or lateral erosion of the margins of the vertebral plates and a varying degree of osteophyte formation. A comparison of the incidence of these disc changes and of osteo-arthritis in our three groups of workers is shown in Fig. 8, from which it will be seen that radiological signs of disc degeneration and osteo-arthritis were found most frequently amongst the miners and least frequently among the office workers, the incidence amongst the manual workers being intermediate. Only some of these apparent differences are statistically significant and these will now be considered in detail. (The χ^2 test was used to determine the probability that a difference such as was observed could have arisen by chance and if in fact there was no real difference between the two groups compared.)

From a study of Table 1 it is clear that radiological signs of disc degeneration in the lumbar spine were found predominantly amongst the miners. Thus if we consider the number of workers with no disc

FIG. 3

FIG. 3.—Slight degeneration of disc between C.6 and 7.

FIG. 4

degeneration there is a highly significant difference between the miners and manual workers ($P < 1.001$), but there is no significant difference between the manual and office workers ($P > 0.1$). If we consider the number of workers showing severe changes the difference between miners and manual workers is also significant ($0.05 > P > 0.02$) while the difference between manual and office workers

FIG. 4.—Severe disc degeneration in cervical spine. Radiographs taken in flexion and extension to show loss of movement between C.6 and 7 and increased movement between C.5 and 6.

FIG. 5A

FIG. 5B

Figs. 5A and 5B.—Antero-posterior and lateral radiographs of knee showing signs of slight osteo-arthritis.

FIG. 6A

FIG. 6B.

Figs. 6A and 6B.—Antero-posterior and lateral radiographs of knee showing signs of severe osteo-arthritis.

is not ($P > 0.2$). If we consider the number of workers with three or more discs affected there is also a significant difference between the miners and manual workers ($P = 0.05$) but the difference between manual and office workers is not significant ($P = 0.25$). These differences are striking and suggest that the increased disc degeneration found in the lumbar spine of the miner is associated with something peculiar to the occupation of mining rather than with the manual work, which is common to both the engineering yard and the mine.

The incidence of osteo-arthritis of the knees is shown in Table 2. Although the differences between the number of miners and manual workers showing no abnormality is not statistically significant ($0.17 > P > 0.05$) it is interesting to note that five of the six men showing severe changes were miners, and there is a general trend in favour of osteo-arthritis amongst the miners. The incidence of ossification in the quadriceps insertion is shown in Table 3. The abnormality was not found quite equally in all three groups but the differences are no more than might be due to chance.

The incidence of disc degeneration in the cervical spine is set out in Table 4 which shows that in this portion of the spine degenerative changes were found equally in the three groups studied. Furthermore the changes in this region are similar in severity and incidence to the changes found in the lumbar spine in the office and manual workers, so that it is only in the lumbar spine of the miner

FIG. 7

FIG. 7.—Lateral radiograph of knee showing ossification in quadriceps insertion.

that a significant increase in disc degeneration was found.

Osteo-arthritic changes in the hands were neither severe nor frequent and consisted mostly of minimal changes in the first carpo-metacarpal or wrist

TABLE 1
LUMBAR DISC DEGENERATION

Occupation	Total Workers	Severity (Grading)							No. of Discs Affected				
		None		Slight		Severe			1	2	3	4	5
Miners	84	7	8%	41	49%	36	43%		16	21	19	9	12
Manual workers ..	45	19	42%	18	40%	8	18%		8	7	9	1	1
Office workers ..	42	28	67%	11	26%	3	7%		8	1	2	3	0

FIG. 8.—Incidence of osteo-arthritis and disc degeneration.

TABLE 2
OSTEO-ARTHRITIS OF KNEES

Occupation	Total Workers	Severity (Grading)					
		None		Slight		Severe	
Miners	84	45	54%	34	40%	5	6%
Manual workers	45	35	78%	9	20%	1	2%
Office workers ..	42	32	76%	10	24%	0	0%

TABLE 3
INCIDENCE OF QUADRICEPS BONE

Occupation	Total	Ossification of Quadriceps Insertion	
Miners	84	8	10%
Manual workers ..	45	10	22%
Office workers ..	42	6	14%

joints. Their incidence is set out in Table 5, which shows that they occurred fairly equally amongst the miners and manual workers but were virtually absent in the office workers. These changes may therefore be associated with manual work.

Of the other joints radiographed because they showed clinical signs of arthritis, there were five elbows, all of which showed osteo-arthritic changes,

and two hips showing slight and severe osteo-arthritis respectively, and all these were in miners. In addition seven shoulders showed slight osteo-arthritis. Four of these were in miners, two in manual, and one in office workers, and osteo-arthritis of the feet was found in four miners and two office workers.

Congenital abnormalities were only noted in the lumbar spine, the number of workers affected being as follows: tropism, 18; sacralization, six; spondylolisthesis, five; spina bifida, six; and scoliosis three. These abnormalities were distributed evenly throughout the three groups, and there was no significant association between any of these changes and a complaint of pain in the low back-sciatic distribution.

Radiological signs of old fractures were noted in 11 workers of whom eight were miners. Of these three were un-united fractures of the scaphoid and one of a tibial condyle, the remaining seven being single wedge-shaped vertebrae suggesting old crush fractures, but as only two of these seven men gave a history of injury to the back this interpretation may not have been correct.

The only bone disease noted was Paget's disease of the spine or pelvis. This was found in three men and was not associated with pain.

Association of X-ray Changes with Symptoms and Signs

The field survey (Lawrence and Aitken-Swan, 1952) showed that coal miners suffer more disability from pain in the lumbar-sciatic distribution and in the knees than many other workers, and the x-ray study shows that lumbar disc degeneration is much more prevalent among miners than among manual or office workers, and that miners may also have more osteo-arthritis in the knees, and it now

TABLE 4
CERVICAL DISC DEGENERATION

Occupation	Total Workers	Severity (Grading)						No. of Discs Affected				
		None		Slight		Severe		1	2	3	4	5
Miners	84	39	46%	30	36%	15	18%	22	18	2	3	—
Manual workers ..	45	26	58%	11	24%	8	18%	10	6	3	0	—
Office workers ..	42	26	62%	8	19%	8	19%	8	4	2	2	—

TABLE 5
OSTEO-ARTHRITIS OF HANDS

Occupation	Total Workers	Severity (Grading)						
		None		Slight		Severe		
Miners	84	70	83%	11	13%	3	4%	
Manual workers	45	40	89%	4	9%	1	2%	
Office workers ..	42	41	98%	1	2%	0	0%	

remains to be seen whether there is any association between these *x*-ray changes and the appropriate symptoms. For this purpose the findings in the 24 miscellaneous workers who had at some time worked underground have been included since no comparison is being made between different occupational groups.

In Table 6 the radiological changes of disc degeneration in the lumbar spine are compared with

TABLE 6
RELATIONSHIP OF LUMBAR DISC DEGENERATION (RADIOLOGICAL) TO SYMPTOMS AND PHYSICAL SIGNS

—	X-ray Changes		
	None	Slight	Severe
Total workers	63	80	52
Workers with pain, lumbar-sciatic	18 (28%)*	26 (32%)	29 (56%)
Workers with limited extension of lumbar spine	11 (16%)	33 (41%)	27 (52%)
Workers with limited straight leg raising	5 (8%)	2 (2%)	1 (2%)

*Percentages represent proportion of all workers with same degree of *x*-ray change. The 24 miscellaneous workers have been included in Tables 6, 7, and 8.

a complaint of pain in the lumbar-sciatic distribution during the past five years, and with certain physical findings such as limitation of extension of the lumbar spine and limitation of straight leg raising. It will be seen that the number of workers with lumbar-sciatic pain in the various *x*-ray gradings is significantly different from the expected number, assuming an even distribution in the various *x*-ray gradings ($0.02 > P > 0.01$). Thus there is a clear association between the *x*-ray changes of disc degeneration and lumbar-sciatic pain. There is also a similar association between limitation of extension of the lumbar spine and *x*-ray changes ($P < 0.01$). Thus the more advanced stages of lumbar disc degeneration which can be appreciated radiologically appear to be associated with more attacks of pain in the lumbar-sciatic distribution and with more frequent limitation of extension in the lumbar spine. On the other hand the limitation of straight leg raising, which is commonly associated with disc prolapse, does not appear to be specially associated with radiological changes in the lumbar spine, and this is in keeping with general clinical

experience. It is interesting to note that despite the evident association between radiological changes and pain, only half those with severe *x*-ray changes complained of pain.

In Table 7 radiological signs of osteo-arthritis in the knees are compared with complaints of pain in the knees during the last five years and with physical signs in the knees, such as limitation of movement, synovial effusion, and crepitus. Again there is a clear association between pain in the knees and *x*-ray changes, the difference between the actual and expected incidence of pain in the *x*-ray gradings being highly significant ($P < 0.01$), and there is a similar association between physical signs and *x*-ray changes.

TABLE 7
RELATIONSHIP OF OSTEO-ARTHRITIS IN KNEES (RADIOLOGICAL) AND PHYSICAL SIGNS

—	X-ray Changes		
	None	Slight	Severe
Total workers	129	59	7
Workers with pain in knees ..	9 (7%)	11 (19%)	5 (70%)
Workers with physical signs in knees	22 (17%)	14 (24%)	5 (70%)

On the other hand the findings are quite different in the cervical spine, as shown in Table 8 where *x*-ray gradings of disc degeneration are compared with a complaint of pain during the past five years in the neck-shoulder-brachial distribution. Here there is clearly no association between pain and *x*-ray changes and only a very slight association between *x*-ray changes and clinical limitation of neck movements.

Although there is a clear association between pain and *x*-ray changes in the lumbar spine and knees, it remains to be seen whether the miners, because of their more arduous work, suffer more pain than manual or office workers with similar *x*-ray changes. For this purpose we have compared the complaint rate in those with and without *x*-ray

TABLE 8
RELATIONSHIP OF CERVICAL DISC DEGENERATION (RADIOLOGICAL) TO SYMPTOMS AND PHYSICAL SIGNS

—	X-ray Changes		
	None	Slight	Severe
Total workers	104	57	34
Workers with pain, cervical-shoulder-brachial	28 (27%)	13 (23%)	7 (21%)
Workers with limitation of neck movements	23 (22%)	19 (33%)	15 (44%)

changes. The results are shown in Table 9 and it will be seen that the complaint rate amongst men with radiological changes is the same in the miners and the other groups. The disability rate in terms of loss of working time due to pain in the appropriate distribution can also be compared with x-ray changes in the miners and the other groups, as shown in Table 9, and again the proportion of workers with x-ray changes who are off work for one week or more is similar in the miners and the other groups. There are slightly more miners off three months or more but the figures are too small to be statistically significant.

It therefore seems likely that the proportion of pain and disability in the low back and knees found amongst miners is more closely related to the high incidence amongst miners of the radiological changes of lumbar disc degeneration and osteoarthritis of the knees than to the arduous nature of their work, except in so far as this is responsible for the x-ray changes.

TABLE 9
COMPLAINT AND DISABILITY RATE

—	Miners		Manual and Office Workers	
	Radiological Changes			
	Absent	Present	Absent	Present
<i>Lumbar disc degeneration</i>				
Total workers ..	7	77	47	40
Workers with pain in lumbar-sciatic distribution ..	2	34 (44%)	14	17 (43%)
Workers off 1 week or more ..	0	19 (25%)	4	10 (25%)
Workers off 3 months or more ..	0	7 (9%)	2	2 (5%)
<i>Osteo-arthritis of knees</i>				
Total workers ..	45	39	67	20
Workers with pain in knees ..	3	9 (23%)	5	5 (25%)

Pains of Undetermined Nature

Although in five men a characteristic past history and residual signs led to a diagnosis of rheumatoid arthritis, the only other substantial group of rheumatic disorders encountered in the clinic study consisted of pain of undetermined nature. Altogether 14 miners, 10 manual, and 17 office workers complained of pain which could not be attributed to any well defined disorder (Table 10). The high incidence among the office workers is largely due to pain in the cervical-shoulder-brachial distribution. For the most part the pain was felt in the trapezius or deltoid muscles, occasionally radiating down the arm to the wrist. In miners the lumbar-sciatic distribution was the most

TABLE 10
SITE OF UNDETERMINED RHEUMATIC PAIN IN MINERS AND OTHER WORKERS

Site of Pain	Miners	Manual	Office
Cervical-shoulder-brachial	3	5	10
Intercostal and abdominal	1	2	2
Lumbar and sciatic	8	3	2
Heel	0	0	1
Multiple	2	0	2
Total	14	10	17
Total workers	84	45	42
Percentage with undetermined pain	17	22	41

frequent site for undetermined pain. The relative proportions with pain at this site were similar to those already encountered for lumbar disc degeneration, the miners having more than the manual workers, and the latter more than the office workers, and it would seem reasonable to suppose that many of these were early cases of disc degeneration in whom x-ray changes had not yet developed.

Pain of undetermined nature was not an important cause of disability; thus only four men lost one week or more of working time from this type of pain.

Psychometric Tests

These will be discussed in detail elsewhere, but it may be said here that the comparison of rheumatic pain with the stability factor derived from these tests did not show any significant general association, although the two miners with undetermined pain at multiple sites were judged to be relatively unstable by both the psychometric tests and the clinician's assessment. It was therefore concluded that relative lack of emotional or mental stability did not contribute materially to the increased incidence of knee and back pain amongst miners though it may be responsible for a few multiple pains of undetermined nature. There was a correlation (0.3) between the stability factor derived from the psychometric tests and the physicians' assessment of mental health.

Causative Factors

A number of causative factors have been studied in relation to x-ray signs of lumbar disc degeneration but only two showed any suggestive association. These were heavy lifting and a history of injury to the back; but a man suffering from disc degeneration might be more prone to remember injuries to the back and to notice heavy lifting, so the significance of these findings is very doubtful. Other factors, such as height, stem height, and a history of exposure to damp, showed no very significant association with x-ray changes. Other factors, such as height of seam and duration of work at the coal

face, were unfortunately too uniform within the group of miners studied to allow for any comparisons. From these preliminary findings it is clear that causative factors can only be assessed by further studies specially designed to demonstrate the effect of individual factors upon the incidence of degenerative joint changes and attacks of disabling pain.

Discussion

From the material presented in this paper it is clear that miners between 40 and 50 years of age suffer from more lumbar disc degeneration and possibly more osteo-arthritis of the knees than either manual or office workers of the same age, and that the preponderance of back and leg pains amongst miners which was found in the previous field survey (Lawrence and Aitken-Swan, 1952) can be largely accounted for by these degenerative joint changes. These findings agree with general clinical experience. Thus Baader (1951) found that out of 4,250 coal miners treated at a special hospital for rheumatic disorders 65% had pain in the lumbar-sciatic distribution, and that about half of these cases had obvious radiological signs of "osteo-arthritis" in the lumbar spine.

Doubt has often been cast upon the significance of these degenerative joint changes as a cause of symptoms since they may be found in people who are not complaining of pain at the time of examination, but in this study their association with episodes of pain during the past five years was clearly demonstrated.

In the field survey it was noted that miners gave a history of increased loss of working time from rheumatic complaints. This might have been simply due to the more arduous nature of the miners' work, but the present x-ray study has shown that miners do in fact have more advanced pathological changes in the joints, and that the complaint rate and disability rate in relation to these radiological changes is much the same in the miners as in the manual and office workers. Thus the miner with a given degree of x-ray change, in spite of the arduous nature of his work, appears to be no more disabled or complaining than the more favourably placed office or manual worker; although this finding may seem surprising, it is in keeping with the relatively low incidence of complaints in mining families which was noted in the field survey.

It is widely held that degenerative joint changes result from injury and occupational or other stress. Coal mining entails much heavy lifting and laborious work, under awkward conditions beneath a low roof which tends to keep the spine in a

flexed position and on an uneven and often steeply inclined floor which makes the foothold insecure, so that the frequency of exceptional stress and injury to the lumbar spine and leg joints in this occupation must be considerable; but the importance of these and other possibly causative factors must be assessed by suitably designed investigations.

The findings of other investigators in men employed in diverse occupations suggest that heavy lifting and laborious work may generally be associated with back troubles and degenerative changes in the spine. Thus Stewart (1947) found a high incidence of degenerative changes in the lumbar spines of dock workers. In the iron and steel trade "rheumatism" is a feature of those occupations such as puddling and steel smelting which involve intermittent short periods of very heavy work (Vernon, 1921), and in such industries the loss of work from "rheumatism" is twice as great as in enginemmen, mill-men, and general labourers. Tellefesen (1949) found that amongst the contributors to the Oslo Sickness Fund loss of work for "rheumatism" was chiefly due to "lumbago" in men, and that incapacity from this cause was most common among builders and dockers and least common among office workers. Although it is impossible to say whether disc degeneration plays as important a part in the back troubles of other workers engaged in heavy lifting as it appears to do in miners, there does appear to be a general association between back pain and occupations entailing heavy lifting.

Much has been written about the psychogenic factor in relation to rheumatism, and Halliday (1948) found a high incidence of psychosomatic disorders among miners in 1930 and in these disorders rheumatic symptoms figured prominently, but our findings in 1951 do not altogether support Halliday's views. Thus although a few miners with pains of undetermined nature felt in multiple sites appeared to be relatively unstable, we did not find any general association between emotional stability and rheumatic complaints. On the other hand we did find a significant association between rheumatic complaints and radiological signs of degenerative joint changes in the lumbar spine and knees, and our general impression is that these joint changes are more important than psychological factors. It should be noted, however, that the social and economic status of the miners has changed considerably since 1930.

Summary

A clinical, radiological, and psychometric study has been made of 84 miners, 45 manual workers,

42 office workers, and 24 miscellaneous workers all of whom were between 40 and 50 years of age.

The miners showed significantly more radiological changes of lumbar disc degeneration and possibly more osteo-arthritis of the knees than either manual or office workers, and there was a significant association between these radiological changes and attacks of pain in the lumbar-sciatic distribution and in the knees. The miners also

showed more arthritic changes in other joints, such as the elbows and hips.

Except in a very small group of men with pain of undetermined nature felt at multiple sites, no association was found between a complaint of pain and relative emotional stability, and it is concluded that degenerative joint changes are mainly responsible for the disabling lumbar-sciatic and knee pain which, in a previous field survey, was found to be more prevalent amongst miners than the general population.

APPENDIX

Fletcher and Oldham (1949) have shown how great observer error can be in the interpretation of chest films taken for pneumoconiosis. Our experience of observer error in the reading of radiographs of the lumbar spine and knees will be discussed in greater detail elsewhere, and is only considered here in so far as it affects our main conclusions.

In Table A the grading of lumbar disc degeneration by four observers is shown. Observers 1 (J.H.K.) and 2 (J.S.L.) were rheumatologists, observer 3 (R.G.W.O.) a radiologist, and observer 4 (J.C.F.C.) an orthopaedic surgeon. It will be observed that, though there are individual differences as to grading and no complete agreement as to the dividing line between slight and normal, all observers agreed as to the main conclusions of the survey. Thus all observers found a higher incidence and a greater severity of disc changes in miners than in manual or office workers. Similarly (Table B) there are differences of opinion as to the number of discs affected but general agreement that multiple disc involvement is a characteristic feature of the

TABLE A
OBSERVER ERROR IN X-RAY DIAGNOSIS OF LUMBAR DISC DEGENERATION (SEVERITY)

Category and Observer				Grading			Total
				None	Slight	Severe	
<i>Miners</i>							
Observer	1	..	..	7	41	36	84
"	2	..	..	10	29	45	
"	3	..	..	9	50	25	
"	4	..	..	18	30	36	
<i>Manual workers</i>							
Observer	1	..	..	19	18	8	45
"	2	..	..	25	9	11	
"	3	..	..	20	16	9	
"	4	..	..	21	12	12	
<i>Office workers</i>							
Observer	1	..	..	28	11	3	42
"	2	..	..	29	10	3	
"	3	..	..	30	12	0	
"	4	..	..	33	6	3	

TABLE B
OBSERVER ERROR IN X-RAY DIAGNOSIS OF LUMBAR DISC DEGENERATION (NUMBER OF DISCS AFFECTED)

Category and Observer				Number of Discs Affected							Total
				0	1	2	3	4	5	6	
<i>Miners</i>											
Observer	1	..	..	7	16	21	19	9	12	0	84
"	2	..	..	10	22	24	16	7	4	1	
"	3	..	..	9	27	24	15	7	2	0	
"	4	..	..	18	28	20	10	6	3	0	
<i>Manual workers</i>											
Observer	1	..	..	19	8	7	9	1	1	0	45
"	2	..	..	25	7	9	4	0	0	0	
"	3	..	..	20	16	6	3	0	0	0	
"	4	..	..	21	19	5	0	0	0	0	
<i>Office workers</i>											
Observer	1	..	..	23	8	1	2	3	0	0	42
"	2	..	..	29	6	5	2	0	0	0	
"	3	..	..	30	4	5	3	0	0	0	
"	4	..	..	33	6	3	0	0	0	0	

miner's spine. In the assessment of osteo-arthritis of the knees as shown in Table C there is again agreement as to the higher incidence and greater severity of the changes in miners but some difference of opinion on grading and normality.

TABLE C
OBSERVER ERROR IN THE X-RAY DIAGNOSIS OF OSTEO-ARTHRITIS OF THE KNEES

Category and Observer				Grading			Total
				None	Slight	Severe	
<i>Miners</i>							
Observer	1	..	..	45	34	5	84
"	2	..	..	54	28	2	
"	3	..	..	67	14	3	
"	4	..	..	60	18	6	
<i>Manual workers</i>							
Observer	1	..	..	35	9	1	45
"	2	..	..	37	8	0	
"	3	..	..	39	5	1	
"	4	..	..	32	13	0	
<i>Office workers</i>							
Observer	1	..	..	32	10	0	42
"	2	..	..	36	6	0	
"	3	..	..	39	3	0	
"	4	..	..	38	4	0	

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