

# RHEUMATOID ARTHRITIS IN A POPULATION SAMPLE

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Many estimates have been made of the prevalence of rheumatic complaints in various populations. In earlier studies information was collected from general practitioners (Ministry of Health, 1924), and later from insurance certificates (Medical Advisory Committee, Scotland, 1945). Field surveys have also been conducted by house-to-house interviews with questionnaires (Woolsey, 1952; Stocks, 1949; Brooke, 1953) and with questionnaires supplemented by clinical examination of individuals with complaints (Edström, 1944; Kellgren, Lawrence, and Aitken-Swan, 1953; Blécourt, 1953).

All these studies have shown that rheumatic complaints as a whole are common, particularly in the older age groups, and that they cause much disability. The prevalence rates for rheumatic complaints as a whole in these different studies are similar if one takes into account the different methods employed for collecting data; but attempts to classify rheumatic complaints into diagnostic categories have given widely divergent results. Thus estimates of the prevalence of rheumatoid arthritis have ranged from 0.4 to 2.3 per cent., and of osteo-arthritis from 0.04 to 6.2 per cent., the lowest rates being those for self-diagnosis in reply to questionnaires published by Stocks (1949), and the highest those for clinical examination in the field obtained by Kellgren and others (1953).

Owing to the lack of diagnostic definition and objective criteria of disease, these divergent estimates of prevalence probably reflect differences of method and language amongst observers rather than a differing incidence of disease, and if any useful epidemiological studies are to be carried out in this field of medicine more precise and reproducible diagnostic definitions must be used and more precise objective criteria of disease must be introduced. The diagnostic difficulty is great, since

conditions such as rheumatoid arthritis and osteo-arthritis can only be recognized clinically with certainty in their most typical and severe forms, which are rare, whereas lesser degrees of arthritis are common and these merge imperceptibly with rheumatic complaints of undetermined nature. Furthermore, the association between pain and anatomical changes in the joints is incomplete, so that complaint rates alone cannot safely be accepted as indices of pathological change.

In studies of osteo-arthritis and disk degeneration, some of these difficulties have been overcome by the use of *x* rays of the relevant joints (Kellgren and Lawrence, 1952; Lawrence, 1955). In the diagnosis of rheumatoid arthritis, Miall and his associates have introduced *x* rays of the hands and feet and/or a positive differential sheep cell agglutination test (Rose, Ragan, Pearce, and Lipman, 1948; Ball, 1950) as essential confirmatory criteria (Miall, Caplan, Cochrane, Kilpatrick, and Oldham, 1953; Miall, 1955). These are real advances, but too little is known about the prevalence of *x*-ray changes and positive agglutination tests in the general population.

To elucidate some of these problems we have studied a sample of the general population in great detail, using radiological and serological as well as clinical techniques, and recording all forms of rheumatic disease in defined grades of severity.

## Population Studied

In 1949-50 rheumatic complaints were studied amongst the adult inhabitants of a 1 in 10 sample of houses in Leigh, an industrial town in Lancashire with a population of some 48,000. For the present investigation all individuals included in this sample who were in the age group 50-59 years in 1949-50 were selected for study. The second survey was carried out in the autumn of 1954, when the individuals studied were 5 years older and with few exceptions came within the age group 55-64 years.

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### Methods of Survey

A preliminary house visit was made by one of us (mostly J.S.L.) who collected information about past and present rheumatic complaints and any resulting disability. A special question was asked about morning stiffness, since Cobb, Warren, Thompson, and Ciocco (1954) and Cobb, Merchant, and Warren (1955) have suggested that morning stiffness might be used as a screening test for rheumatoid arthritis. Such information as could be obtained from clinical examination of the hands was also recorded. An appointment was then made to attend a special examination centre where a more detailed clinical and occupational history was taken.

At this examination the question about morning stiffness was repeated; and a separate question was asked about back pain, lumbago, sciatica, and neuritis. A special question about the occurrence of rheumatism, rheumatic fever, or arthritis in childhood or early adult life was also included, and the replies recorded as "past polyarthritis" with dates and duration as far as these could be ascertained.

The hands were then examined for Heberden's nodes, arthritis of first carpo-metacarpal joint, reduced peripheral circulation, sweating, tendon nodules, and tendon sheath swellings, and each characteristic was recorded as absent or present in doubtful, slight, or severe degree.

A more complete examination of the joints was carried out on a couch, the following characteristics being noted:

- (1) pain on movement and pressure,
- (2) joint warmth, swelling, effusion, or bony enlargement,
- (3) range of motion, whether normal, or slightly or severely restricted, and whether accompanied by crepitus.

The spine was examined standing and a note was made of the spinal curves and mobility. Spinal movements were recorded separately for the cervical and lumbodorsal regions.

The findings in the following joints were recorded separately for the left and right sides of the body: proximal interphalangeal and metacarpo-phalangeal joints in the hands, the wrists, elbows, shoulders, hips, knees, ankles, tarsal joints, and the lateral and first metatarso-phalangeal joints in the feet. The presence of subcutaneous nodules was also recorded. An opinion had to be expressed about the presence of rheumatoid

arthritis, generalized osteo-arthritis as defined by Kellgren and Moore (1952), local traumatic or secondary osteo-arthritis, disk degeneration or prolapse, other defined rheumatic complaints such as gout, spondylitis, and rheumatic fever, psychogenic rheumatism, and pain of undetermined nature. These diagnostic categories were recorded either as absent or as present in doubtful, slight, moderate, or severe degree. The examiner's impression of the individual's personality, whether normal, neurotic or psychotic, was also recorded.

The height and weight were recorded, and a sample of blood taken for the differential sheep cell agglutination test (D.A.T.). Antero-posterior radiographs were taken of hands, feet, knees, and pelvis, and lateral radiographs of the lumbar and cervical spine. A few individuals who were unable or unwilling to come to the centre were examined and x-rayed in their own homes, but in these cases only radiographs of the hands and feet were obtainable.

The information collected was thus fairly extensive and can be analysed from many points of view, but in this report we shall confine ourselves to a study of rheumatoid arthritis.

### Completeness of Survey

The records of the previous survey in Leigh, Lancs. (which at that time was a complete 1 in 10 sample) provided 537 persons in the age group selected for study and of these 237 were men. From the home visits it was ascertained that 34 of these individuals had died and 22 had removed from the area, leaving an available total of 481. Of these fourteen refused to be seen, so that the home interview in this study is 97 per cent. complete. 87 refused to be x-rayed. In a further thirty cases the blood test was refused or its results were unsatisfactory, so that the serological survey is only 73 per cent. complete (Table I).

Since this is primarily a correlation study, this lapse rate was accepted because of the very considerable labour required for greater completion.

The 1949-50 records and inquiries from relatives showed that amongst the 56 individuals who had died or removed there was no undue prevalence of polyarthritis. The 87 individuals who refused x ray were generally without significant rheumatic symptoms except for one woman who at the home interview was judged to have rheumatoid arthritis of moderate severity.

For simplicity, only the results from the 380 persons x-rayed will be analysed in detail.

TABLE I  
COMPLETENESS OF SURVEY

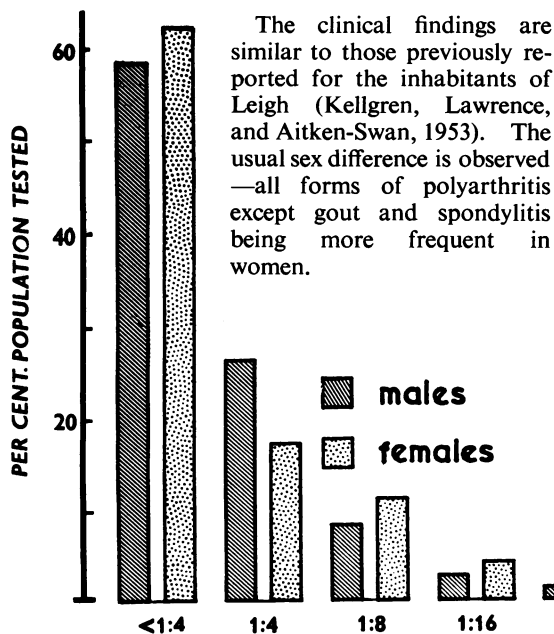
Sex	No. in 1949-50 Sample	Not Available		Total Available	Refused Interview or Never at Home	Interviewed but Refused x Ray	Interview and x Ray	Interview, x Ray, and Blood Test
		Dead	Moved out of District					
Men .. .. .	237	25	8	204	6	25	173	163
Women .. .. .	300	9	14	277	8	62	207	187
Total .. .. .	537	34	22	481	14	87	380	350

**Results**

**Clinical Findings.**—The prevalence of clinical polyarthritis amongst the 380 persons x-rayed is shown in Table II. All definite cases, whether slight or severe, are included. In some instances, particularly those with osteo-arthritis, there was no complaint of pain in spite of very definite physical findings in the joints and these cases have been included as positive. Concurrent rheumatoid arthritis and generalized osteo-arthritis were only noted in eight women, although in hospital clinics this combination is fairly frequently seen, but this may simply be due to the fact that only a highly selected sample of the population attends hospital.

TABLE II  
CLASSIFICATION OF CLINICAL POLYARTHRITIS

Clinical Diagnosis	Sex			
	Men		Women	
	No.	%	No.	%
Rheumatoid Arthritis only	5	3	22	11
Generalized Osteo-arthritis only	21	12	69	33
Rheumatoid Arthritis + Generalized Osteo-arthritis	0	0	8	4
Psoriatic Arthropathy	1	0.6	0	0
Gout	2	1	0	0
Spondylitis	2	1	0	0
Total Polyarthritis	31	18	99	48
Total Surveyed	173	100	207	100



The clinical findings are similar to those previously reported for the inhabitants of Leigh (Kellgren, Lawrence, and Aitken-Swan, 1953). The usual sex difference is observed—all forms of polyarthritis except gout and spondylitis being more frequent in women.

When we consider the serological and radiological evidence of rheumatoid arthritis some unexpected findings emerge.

**Serological Findings.**—The D.A.T. was performed by Dr. J. Ball, using his 1950 method, the test being recorded as positive if agglutination occurred in a dilution of 1 : 32 at 18 hrs.

The serological findings in the 163 men and 187 women tested are illustrated in Fig. 1. It is apparent that the general distribution of titres in the two sexes is almost identical. Amongst the men there were eight (5 per cent.) with positive tests, and amongst the women eleven (6 per cent.). If it is assumed that all those not tested would be negative, the minimal prevalence of positive tests in this age group in Leigh would be about 4 per cent., but this is almost certainly not a safe assumption so that the true prevalence is likely to be nearer 5 per cent.

**Radiological Findings.**—Radiological evidence of rheumatoid arthritis is usually sought in films of the hands and feet, and observer differences of interpretation and the reproducibility of individual readings have been studied recently (Kellgren, 1956). To reduce errors to a minimum the films of the hands and feet in this survey were all taken by a standard technique, and a control bone was included in the hand films. These films were then read three times. The first reading was done jointly by both of us and the second by one of us reading alone. For these two readings rheumatoid changes as a whole were graded as follows:

- 0 = None,
- 1 = Doubtful,
- 2 = Slight,
- 3 = Moderate,
- 4 = Severe.

In the third reading, done jointly, porosis and erosions were graded separately in the same categories, and on this third occasion porosis was recorded irrespective of its cause. This is important

Fig. 1.—Distribution of titres in differential sheep cell agglutination test found amongst 350 patients aged 55 to 64 years (163 men and 187 women).

since the most pronounced porosis was seen in association with fractures, neurological disorders, and other obviously non-rheumatoid conditions, some of which could be recognized from the radiological appearances alone.

A composite score was obtained by adding the first two readings to the score for porosis or erosion, whichever was the highest. A score of 5 or over for the three readings was taken as positive.

Radiological changes of this grade or above were found in the hands and/or feet in seventeen women (8 per cent.) and twelve men (7 per cent.). If we assume that all those not x rayed were negative, minimal prevalence rates would be 6 per cent. for each of the two sexes. Although the radiological changes of rheumatoid arthritis are not so easily recognized in the larger limb joints and spine, the cervical spine and larger limb joints are very often affected by this disease. Slight changes in these

joints were thought to be too difficult to interpret, but moderate or severe changes were considered worth recording. In the first reading seven individuals in whom the films of hands and feet had a composite score of less than 5 and were therefore classed as negative showed destruction of disks and irregularity of the interfaccetal joints in the cervical spine which were thought to be rheumatoid in nature. On re-reading these spinal films two were discarded as probably non-rheumatoid, leaving five individuals with positive films of the cervical spine. Two were men, and of these one had a positive D.A.T. and the other had borderline changes in the hand films and a past history of severe polyarthritis in adult life. Of the three women with moderate changes in the cervical spine, all three had borderline changes in the hand films, and one had a positive D.A.T. and clinical rheumatoid of slight severity, the second gave a history of polyarthritis,

TABLE III  
X-RAY SIGNS IN 173 MEN AND 207 WOMEN

Reading	Sex	Grade									
		0		1		2		3		4	
		No.	%	No.	%	No.	%	No.	%	No.	%
Rheumatoid Arthritis (first reading of all joints)	Men	93	54	60	35	15	9	3	2	2	1
	Women	99	48	83	41	14	7	7	3.5	4	2
Porosis (hands only)	Men	164	96	7	3	2	1	0	0	0	0
	Women	125	60	45	21	31	15	4	2	2	1
Erosions (hands only)	Men	132	75	27	16	12	7	0	0	2	1
	Women	168	82	23	11	11	5	3	1.5	2	1

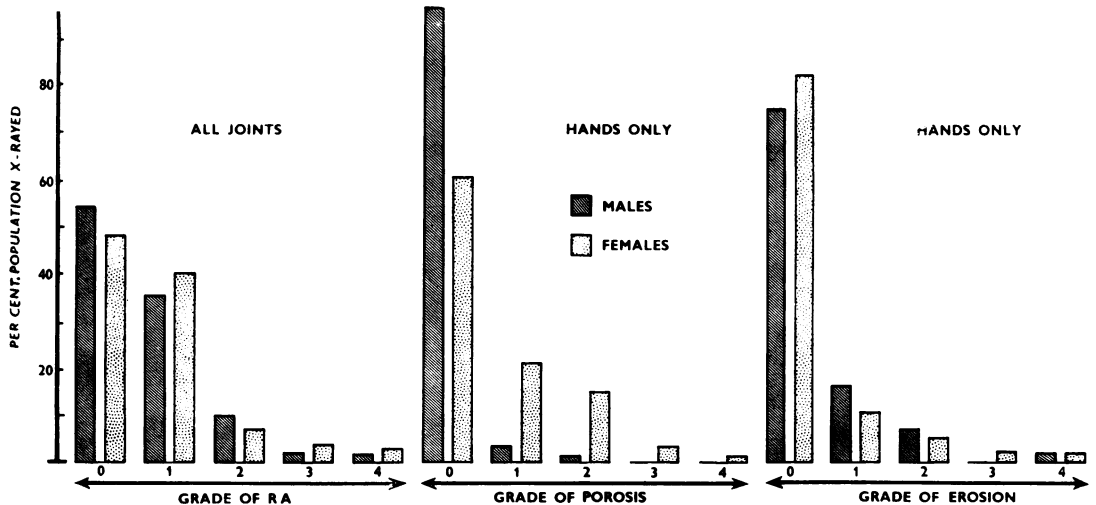


Fig. 2.—Distribution of x-ray gradings of rheumatoid arthritis in 380 persons aged 55 to 64 years, by sex, taking the most seriously affected joint in each individual (from first reading of films), and distribution of osteoporosis and erosion in hand films only (from third reading of films).

and the third showed no other evidence of rheumatoid arthritis.

These additional five cases have been considered radiologically positive, bringing the final figure up to twenty women (10 per cent.) and fourteen men (8 per cent.).

The distribution of the x-ray changes of rheumatoid arthritis would therefore also appear to be similar in the two sexes in this age group. On the other hand, osteoporosis when read separately appears to be largely confined to women; Table III and Fig. 2 show the distributions by grades of porosis and erosion in the hands based on the results of the third reading of the films, and for comparison the results by grades of rheumatoid changes recorded during the first reading of all the films.

We are well aware of the difficulty of assessing osteoporosis in radiographs of the hands, but the pronounced sex difference observed may well be real and certainly requires further investigation.

**Comparison of Clinical, Radiological, and Serological Findings**

The association between the clinical gradings of rheumatoid disease and positive x-ray findings and/or a positive agglutination test is set out in Table IV and Fig. 3.

Clinical rheumatoid arthritis of moderate or severe degree was found in three men and seven women, and this small group will for simplicity be called the severe group. In one man there was neither serological nor radiological confirmation of the diagnosis, but in the other two men and in all seven women such confirmation was obtained, two men and two women having both a positive D.A.T. and positive x rays, four women having positive x rays only, and one a positive D.A.T. only.

Clinical rheumatoid arthritis of only slight degree was noted in only two men and in one of these the D.A.T. was positive. By contrast, clinical rheuma-

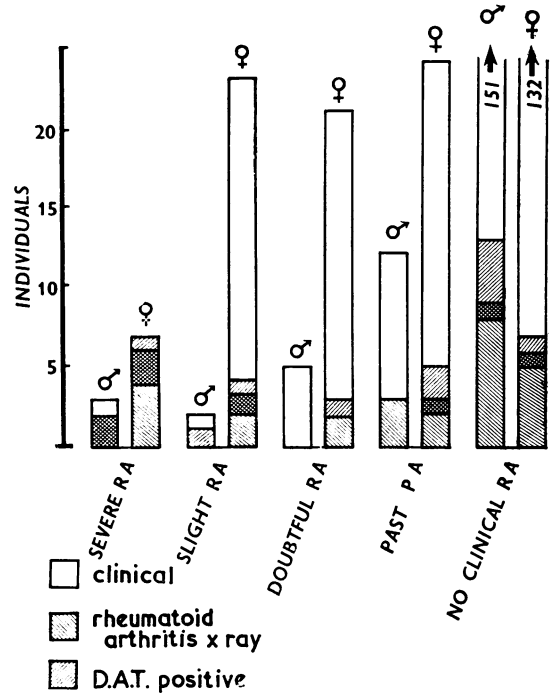


Fig. 3.—Correlation between clinical, radiological, and serological evidence of rheumatoid arthritis in persons x-rayed (173 men and 207 women). Columns represent actual number of individuals in each diagnostic group.

toid arthritis of slight degree was noted in 23 women, but in only four was the diagnosis confirmed, twice by x ray alone, once by D.A.T. alone, and once by both criteria.

Doubtful clinical evidence of rheumatoid arthritis was noted in five men and 21 women. Both x rays and D.A.T. were negative in all five men and in eighteen of these women, but two women had positive x rays and one a positive D.A.T.

A past history of polyarthrits with no clinical evidence of rheumatoid disease at the time of examination was noted in twelve men and 24

TABLE IV  
COMPARISON OF CLINICAL, RADIOLOGICAL, AND SEROLOGICAL EVIDENCE OF RHEUMATOID ARTHRITIS

Clinical Grade	No. of Men					No. of Women				
	X Ray Only	D.A.T. Only	X Ray and D.A.T.	X Ray and/or D.A.T.	Total	X Ray Only	D.A.T. Only	X Ray and D.A.T.	X Ray and/or D.A.T.	Total
Severe Rheumatoid Arthritis	0	0	2	2	3	4	1	2	7	7
Slight Rheumatoid Arthritis	0	1	0	1	2	2	1	1	4	23
Doubtful Rheumatoid Arthritis	0	0	0	0	5	2	1	0	3	21
Past Polyarthrits	3	0	0	3	12	2	2	1	5	24
No Rheumatoid Arthritis	8	4	1	13	151	5	1	1	7	132
Total	11	5	3	19	173	15	6	5	26	207

N.B.—Of the ten men and twenty women in whom the D.A.T. was not performed, nine men and eighteen women showed no clinical evidence of rheumatoid arthritis, but one of the nine men showed radiological evidence. The remaining three subjects had past polyarthrits or doubtful clinical rheumatoid arthritis and none of these showed radiological evidence of rheumatoid arthritis.

women. Three of these twelve men had positive x rays, but none had a positive D.A.T. Of the 24 women, two had positive x rays, two had a positive D.A.T., and one was positive by both criteria.

Lastly, there were 151 men and 132 women who were not considered to have any clinical evidence of rheumatoid arthritis. Amongst the 151 men, there were eight with positive x rays, four with a positive D.A.T., and one with both. Amongst the 132 women, there were five with positive x rays, one with a positive D.A.T., and one with both. Thus, there were thirteen men and seven women presenting radiological and/or serological evidence of rheumatoid arthritis who were recorded as having no clinical rheumatoid arthritis in the opinion of the

examiner. The findings in these twenty individuals are set out in Table V. Nearly all of them had either symptoms or clinical findings in the joints which in retrospect might have been at least partly attributed to rheumatoid disease. The fact that no clinical rheumatoid arthritis was recorded may therefore represent only a failure in diagnosis.

When the hands and feet are involved the clinical diagnosis of rheumatoid arthritis is relatively easy, but the diagnosis of rheumatoid arthritis of the larger joints and spine presents great difficulties. At a certain stage of the disease it may be confined to the cervical spine, knees, shoulders, or other limb joints, and clinical diagnosis may be very difficult. This may possibly have been the case in some indivi-

INDIVIDUALS WITH POSITIVE X RAY AND/OR D.A.T. RE

Case No.	Sex	Age	D.A.T.	Radiological Findings			
				Rheumatoid Arthritis		Osteo-arthritis	
				Grade	Site	Grade	Site
190	M	57	1/256	None	—	Slight	Hands, feet, spine
191	M	57	1/32	Moderate	Cervical spine	Moderate	Cervical spine
215	M	55	1/64	Doubtful	Feet	None	—
300	M	60	1/32	None	—	None	—
333	M	60	1/64	Doubtful	Hands	Slight	Knees, spine
W.7	F	64	1/32	Slight	Feet	None	—
14	F	62	1/128	None	—	Slight	Hands, feet
55	M	58	1/<4	Slight	Hands	Moderate	Knees, spine, hands
82	M	62	1/4	Slight	Hands	Slight	Hands
140	M	61	1/<4	Slight	Hands	Slight	Hips, knees, hands
155	M	57	1/<4	Slight	Hands	Slight	Hands, hips, spine
201	M	56	1/<4	Slight	Hands	Moderate	Cervical spine
341	M	64	1/8	Slight	Hands	Slight	Hands, knees
372	M	59	—	Slight	Hands	Slight	Spine, left knee
378	M	58	1/<4	Slight	Hands	Moderate	Spine
W.22	F	55	1/<4	Slight	Feet	Severe	Hands
180	F	64	1/16	Slight	Hands	Slight	Hands, spine, knees, protrusio acetabuli
194	F	58	1/<4	Slight	Hands	Severe	Hands
226	F	58	1/<4	Slight	Hands	Slight	Cervical spine
277	F	63	1/4	Moderate	Cervical spine	Slight	Hands, feet

duals in Table V, such as Nos. 191, 215, 82, 140, 155, 378, 180. In others there may have been an error in interpretation of *x* rays; this seems likely in No. 372, where there was a past history of fracture, and in Nos. 55, W.22, 194, where there was severe osteoarthritis. These remarks only serve to remind us of the real difficulties in both clinical and radiological diagnosis in rheumatic disease, especially in slight and atypical cases.

The association between moderate and severe clinical rheumatoid arthritis and a positive *x* ray or D.A.T. is obviously highly significant, but what of the other clinical categories? If we group together past polyarthritis and slight and doubtful clinical rheumatoid arthritis, and compare this group with

the individuals recorded as having no clinical evidence of rheumatoid disease, we find that positive *x* rays and positive agglutination tests are both more frequent in this admittedly dubious diagnostic group. The probability of the distribution found being due to chance alone is not great: for positive *x* rays  $P < 0.02$ , for positive D.A.T.  $P < 0.05$ , for both criteria together  $P < 0.001$ .

The association between clinical diagnosis and radiological and serological findings outside the small group of patients with severe typical rheumatoid arthritis is most unsatisfactory, particularly in the men, in whom thirteen of the nineteen with objective criteria were recorded as having no clinical evidence of rheumatoid arthritis.

ED AS HAVING NO CLINICAL RHEUMATOID ARTHRITIS

Symptoms	Clinical Signs of Joint Disease	Clinical Diagnosis
lumbago one attack; pain in hip	Back, reduced curves, limited motion, vasospasm	Disk degeneration
trivial pains fingers and toes	One doubtful traumatic Heberden's node	Normal
recurrent lumbago; few days' pain in arms	Crepitus in shoulders, limited lumbar spine, vasospasm, sweating	Osteo-arthritis and disk degeneration
one	Contracture palmar fascia	Dupuytren's contracture
after crush injury to feet, 5 yrs' pains in thumbs, knees, back, feet	Crepitus in knees, tender thickening of lateral metatarso-phalangeal joints	Osteo-arthritis
1 yrs' pain in ankle and neck after sprained ankle	None	Undetermined
one	Heberden's nodes, hallux rigidus, cervical spine limited	Osteo-arthritis
1 yrs' pain and stiffness left knee after severe sciatica at age 43	Left knee very limited and crepitant	Osteo-arthritis (traumatic) and disk degeneration
1 yrs' recurrent back pain after injury	Limited wrists and lumbar spine, fluid and crepitus in knees	Osteo-arthritis and disk degeneration
1 yrs' stiffness right knee; lumbago over 15 yrs ago	Fluid and crepitus in knees, limited elbows, wrists, and spine, vasospasm in extremities	Osteo-arthritis and disk degeneration
1 yrs' pain right knee and thigh; severe lumbago at age 22	Limited spine, right hip and both wrists	Osteo-arthritis and disk degeneration
one	Thickened metacarpo-phalangeal joints, ? limited cervical spine, vasospasm	Normal
1 yrs' recurrent lumbago and sciatica	Limited right elbow and lumbar spine, nodule on elbow	Osteo-arthritis and psychogenic rheumatism
0 symptoms; past fracture left wrist and left femur	None	Normal
1 yrs' pain in dorsal region of back and shoulders	Limited cervical and lumbar spine, shoulders painful	Osteo-arthritis and disk degeneration
1 yrs' pain in fingers and knees	Severe Heberden's nodes, limited elbow and right knee	Osteo-arthritis
1 yrs' pain and stiffness hips and knees	Right hip very limited, spine and right knee limited	Osteo-arthritis and disk degeneration
1 yrs' knobby fingers; no pain	Severe osteo-arthritis fingers, effusion in knee	Osteo-arthritis
1 yrs' ago one attack neuritis right arm	Slight right palmar fascia contracture, vasospasm, sweating	Undetermined
1 yrs' pain left shoulder	Subluxation lateral metatarso-phalangeal joints	Undetermined

Table VI shows the relationship of osteoporosis of the hands in women to clinical rheumatoid arthritis or a positive D.A.T.; four of the seven women with severe clinical rheumatoid arthritis have definite osteoporosis, 28 of the 177 women without definite clinical rheumatoid arthritis have osteoporosis, and of the 37 women with definite porosis only nine have definite clinical rheumatoid arthritis. In this age group, therefore, only about one-quarter of the osteoporosis recorded as present in the hand films was associated with clinical rheumatoid arthritis, and only one case in eight had a positive D.A.T.

TABLE VI  
COMPARISON OF OSTEOPOROSIS IN THE HANDS WITH  
CLINICAL AND SEROLOGICAL EVIDENCE OF  
RHEUMATOID ARTHRITIS IN WOMEN

Grade of Porosis		0	1	2	3 & 4	Total
Grade of Clinical Rheumatoid Arthritis	Severe	2	1	1	3	7
	Slight	14	4	5	0	23
	Not definite	109	40	25	3	177
Total		125	45	31	6	207
Result of D.A.T.	Positive	6	1	3	1	11
	Negative	105	40	25	5	175
	Total	111	41	28	6	186

#### Comparison with Previous Survey

Detailed comparisons between the findings in the two surveys are not possible, since in 1949-50 only a single diagnosis was recorded, whereas in the present study multiple diagnoses were frequently made. Furthermore, during the lapse of 5 years some individuals had recovered from their old complaints, whilst many others had developed new complaints. Nevertheless, we have reviewed the 24 women and eleven men from the sample *x* rayed in 1954 who were diagnosed as having rheumatoid arthritis on clinical grounds alone in 1949-50.

*Women.*—In the second study ten of these 24 women were considered to have definite clinical rheumatoid arthritis, four doubtful rheumatoid, and ten no clinical evidence of rheumatoid arthritis.

Of the ten recorded as negative, two were bedfast with obscure painful disorders of the locomotor system which on review were thought to be mainly due to disease of the nervous system, six were considered to have generalized osteo-arthritis, one gave a past history of constitutional illness with swelling of the knees but had no symptoms or signs of arthritis at the time of the second examination, and one gave a past history of severe rheumatic fever at ages 7 and 22, with persistent limb pains, and on examination was found to have a stiff back, abnormal mobility in the joints of the extremities,

and radiological signs interpreted as osteo-arthritis in one knee and spondylitis or osteo-arthritis in the sacro-iliac joints.

*Men.*—The findings in the eleven men were similar: on review in 1954, three were considered to have definite rheumatoid arthritis, six osteo-arthritis, one disk degeneration and past poly-arthritis, and one gave a clinical history of severe polyarthritis in adolescence and now presented with a rigid back, chest expansion of 2 cm., and limitation of movement in hips and shoulders. In this patient spondylitis was diagnosed clinically with some confidence, but *x* rays showed normal sacro-iliac joints, osteo-arthritis of the hips, disk degeneration, and severe Paget's disease.

*Severe Cases.*—Perhaps the most interesting finding was that of the ten subjects (seven women and three men) recorded as having moderate or severe rheumatoid arthritis in 1954, seven (five women and two men) had been previously diagnosed as having rheumatoid arthritis in 1949-50, while in two of the remaining three the disease had started after the first survey. Thus in only one of these ten severe cases was the diagnosis different, having been recorded as rheumatic fever during the first survey and rheumatoid arthritis during the second.

#### Clinical Screening Test

Cobb, Warren, Thompson, and Ciocco (1954), and Cobb, Merchant, and Warren (1955) have suggested that morning stiffness might be used as a clinical screening test for rheumatoid arthritis in field surveys. A standard question about morning stiffness was therefore asked during the home interview and again while taking the history before the clinical examination. At the home interview, morning stiffness was recorded as present in 132, and at the clinic interview in 118, but only in 74 individuals was the symptom recorded as positive at both interviews; thus there was a wide difference between observers in recording this characteristic. The association between this symptom and other evidence of rheumatoid arthritis is set out in Table VII (opposite). There appears to be a slight association between morning stiffness as recorded at the clinic and other evidence of rheumatoid arthritis, though this association is not improved by taking only those individuals in whom morning stiffness was recorded at both interviews; also the morning stiffness recorded at the home interview shows virtually no association with other evidence of rheumatoid arthritis. Although morning stiffness is usually pronounced in active rheumatoid arthritis, it may be absent when the disease is in remission in spite of severe anatomical changes in the joints.



TABLE VII  
CLINICAL SCREENING TESTS FOR RHEUMATOID ARTHRITIS

Clinical Characteristic	Where Recorded	Positive D.A.T.		Radiological Rheumatoid Arthritis		Clinical Rheumatoid Arthritis		Doubtful Rheumatoid Arthritis or Past Polyarthritis		No Rheumatoid Arthritis		Whole Sample	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Morning Stiffness .. .. .	Clinic	8	42	14	41	25	71	27	44	60	23	118	31
	Home and Clinic	5	26	10	29	15	43	16	26	49	19	74	20
	Home	5	26	16	47	17	49	28	45	103	39	132	35
Cold Blue Extremities .. .. .	Clinic	6	32	9	26	19	54	11	18	23	9	57	15
Sweating .. .. .	Clinic	3	16	12	35	10	29	10	16	26	10	50	13
Tendon Nodules .. .. .	Clinic	4	21	7	21	14	40	4	6	14	5	33	9
Subcutaneous Nodules .. .. .	Clinic	3	16	4	12	6	17	4	6	0	0	11	3
Whole Sample .. .. .		19	100	34	100	35	100	62	100	264	100	380	100

Furthermore, our experience of hospital patients suggests that osteo-arthritis of the large limb joints and disk degeneration may also be associated with morning stiffness, particularly in middle-aged and elderly subjects. In the age group studied, morning stiffness certainly did not appear to provide a useful screening test for rheumatoid arthritis, but it may be more valuable in younger age groups.

Other clinical features such as cold blue extremities, sweating, and tendon nodules in the hands, as recorded at the clinic interview, show some association with rheumatoid disease. Subcutaneous nodules both on the elbows and under the heels were not found in any individuals who had no other evidence of rheumatoid arthritis, but the number of nodules recorded was very small. These three characteristics are clearly found too infrequently to be of any value as screening tests, and the observer error between the home and clinic interviews was even greater than for morning stiffness. As recorded in the clinic interview, these characteristics appear to be reasonably specific, so that cold blue extremities, sweating, and tendon nodules should probably be included in the clinical records as aids to diagnosis.

### Discussion

Since the population studied was confined to the 55-64 age group and was drawn exclusively from one town in Lancashire, no general conclusions about prevalence rates can be based on the data presented.

The findings do, however, raise interesting questions about the validity of our diagnostic criteria and of our methods of estimating the prevalence of rheumatoid arthritis in population samples. It would appear that severe typical

rheumatoid arthritis involving the hands and feet can be recognized with some certainty, since the individuals with this disease were picked out in both surveys, and in nine out of ten of these cases the clinical diagnosis was confirmed by either a positive D.A.T. or positive *x* ray or both. The significance of a clinical diagnosis of slight and doubtful rheumatoid arthritis or past polyarthritis is questionable, and it seems unlikely that a clinical diagnosis at this level of severity could be made reproducible in the older age groups in which osteo-arthritis and other painful conditions of the limbs are so common. Furthermore, this large diagnostic group of 87 individuals contained only sixteen in whom the diagnosis of rheumatoid arthritis was confirmed by a positive *x* ray and/or D.A.T. These objective findings were, however, significantly more frequent in this vague diagnostic group than in the 283 individuals recorded as having no clinical evidence of rheumatoid arthritis. The degree to which this large but dubious diagnostic group is included will radically alter any estimates of the prevalence of rheumatoid disease, even if cases are accepted only when the *x* ray or D.A.T. is positive, as can be seen from Table VIII and Fig. 4 (overleaf), which show the various prevalence rates for rheumatoid arthritis amongst men and women in the 55-64 age group in Leigh that can be derived from our data. Table VIII shows that comparisons of prevalence rates in different populations would be of little value unless the method of survey were similar and the diagnostic criteria carefully defined.

For practical purposes there appears to be a useful clinical dividing line at "typical rheumatoid arthritis of moderate or great severity affecting the hands and feet". If all cases considered positive by this

TABLE VIII

MINIMAL PREVALENCE OF RHEUMATOID ARTHRITIS BASED ON AVAILABLE  
SAMPLE OF POPULATION AGED 55-64 YEARS

Clinical Evidence of Rheumatoid Arthritis	Sex							
	Men				Women			
	Total		With Positive X Ray and/or D.A.T.		Total		With Positive X Ray and/or D.A.T.	
	No.	%	No.	%	No.	%	No.	%
Severe . . . . .	3	1.5	2	1	7	3	7	3
Slight and Severe . . . . .	5	2.5	3	1.5	30	11	11	4
Doubtful, Slight, and Severe . . . . .	10	5	3	1.5	51	18	14	5
All Grades plus Past Polyarthritits . . . . .	22	11	6	3	75	27	19	7
Total X-Rayed . . . . .	173	85	19	9	207	75	26	9
Total Available . . . . .	204	100			277	100		

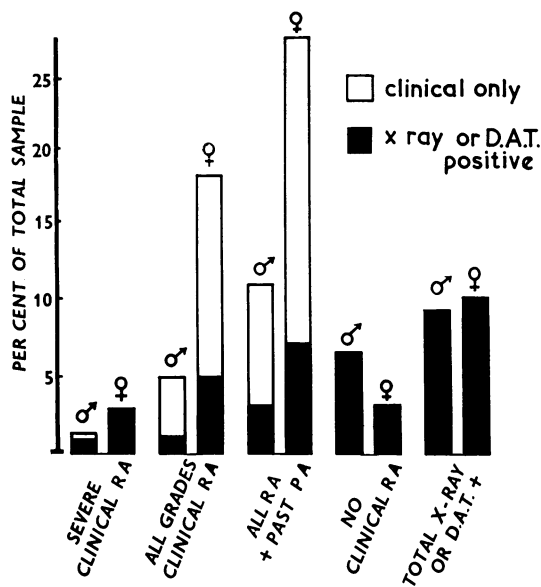


Fig. 4.—Range of minimal prevalence rates for rheumatoid arthritis in 55-64 age group in Leigh, calculated from total available sample of 204 men and 277 women, assuming all individuals not x-rayed or tested to be negative.

clinical definition have their hands, feet, and cervical spine x-rayed and a D.A.T. performed, a useful objective check can be maintained on the level of clinical diagnosis. Such a method of survey should be useful for screening large populations since at most 3 per cent. of the population would require detailed investigation. This corresponds roughly to the method used by Miall and others (1953), though their clinical dividing line was probably at a lower level of severity and they did not take x rays of the cervical spine. This method should give a good indication of the prevalence of rheuma-

toid disease of the peripheral limb joints, but it could not be used to estimate the prevalence of clinical polyarthritits as a whole, nor could it be used safely to estimate the prevalence of positive x ray changes or positive serological tests in the population studied. In our present state of ignorance it would seem essential to study completely small but carefully selected samples of any population under investigation. In such studies clinical, radiological, and serological data should be collected on all individuals in the population sample, whether a clinician thinks they have rheumatoid arthritis or not.

Clinical rheumatoid arthritis as defined by our present diagnostic practice is generally agreed to be about three times as common in women as in men, and the findings in this survey are no exception. However, in this survey radiological signs of rheumatoid arthritis in the hands and feet were found equally in both sexes and the distribution of titres in the D.A.T. was also practically identical. Perhaps the most disturbing finding was that there were thirteen men and seven women with "objective evidence" of rheumatoid disease, namely a positive x ray and/or D.A.T., but no clinical evidence. This result could be due to lack of specificity of the radiological and serological findings or to errors of clinical diagnosis. It must be remembered that rheumatoid disease may sometimes affect mainly the central joints and cervical spine or non-articular structures and is then rarely recognized clinically as such, especially under survey conditions. Radiological signs of polyarticular osteo-arthritis were found more frequently in women than men in this age group, so that the preponderance of clinical polyarthritits in women may well be in some way connected with this greater prevalence of the radiological signs of osteo-arthritis and/or osteoporosis in women. These questions are important for clini-

cal as well as epidemiological work, but more data are required before they can be properly discussed.

### Summary

(1) A sample of individuals aged 55-64 years from an urban population were examined clinically, radiologically, and serologically for evidence of rheumatoid arthritis.

(2) Clinical rheumatoid arthritis at all grades of severity was found twice as frequently amongst the women, but the titre values in the sheep cell agglutination test were distributed equally between the sexes. Radiological evidence of rheumatoid arthritis was also found equally in men and women.

(3) In nine out of ten individuals with severe clinical rheumatoid arthritis the diagnosis was confirmed by positive x ray and/or agglutination test. With lesser degrees of clinical disease such confirmation became less frequent, and there were twenty individuals with positive x rays and/or agglutination tests amongst 283 who were considered to be free from clinical rheumatoid arthritis.

(4) The prevalence rates range from 1 per cent. for men and 3 per cent. for women with severe clinical rheumatoid arthritis confirmed by x ray and/or agglutination test to 11 per cent. for men and 27 per cent. for women with all grades of clinical disease including a past history of polyarthritis. Precise diagnostic definition is therefore essential for the study of comparative prevalence rates in different populations.

This work was assisted by a grant-in-aid from the Medical Research Council, and we are particularly grateful to members of the academic and technical staff of the Council's Pneumoconiosis Research Unit for their help in many aspects of the field study and especially in the taking of x rays. We owe a special debt to Dr. J. Ball for carrying out all the agglutination tests.

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### REFERENCES

- Ball, J. (1950). *Lancet*, 2, 520.  
 Blécourt, J. J. de (1953). *Rev. Rhum.*, 20, numéro special, p. 105.  
 Brooke, E. M. (1953). *Monthly Bull. Minist. Hlth (Lond.)*, 12, 114.  
 Cobb, S., Merchant, W. R., and Warren, J. E. (1955). *J. chron. Dis.*, 2, 50.  
 —, Warren, J., Thompson, D., and Ciocco, A. (1954). *Penn. med. J.*, 57, 37.  
 Edström, G. (1944). *Upsala Läk Fören. Förh.*, 49, 303.  
 Kellgren, J. H. (1956). *Annals of the Rheumatic Diseases*, 15, 55.  
 —, and Lawrence, J. S. (1952). *Brit. J. industr. Med.*, 9, 197.  
 —, —, and Aitken-Swan, J. (1953). *Annals of the Rheumatic Diseases*, 12, 5.  
 —, and Moore, R. (1952). *Brit. med. J.*, 1, 181.  
 Lawrence, J. S. (1955). *Brit. J. industr. Med.*, 12, 249.  
 Medical Advisory Committee (Scotland) (1945). "Chronic Rheumatic Diseases." H.M.S.O., Edinburgh.  
 Miall, W. E. (1955). *Annals of the Rheumatic Diseases*, 14, 150.  
 —, Caplan, A., Cochrane, A. L., Kilpatrick, G. S., and Oldham, P. D. (1953). *Brit. med. J.*, 2, 1231.

- Ministry of Health (1924). "The Incidence of Rheumatic Diseases," ed. G. Newman. Reports on Public Health and Medical Subjects, No. 23. H.M.S.O., London.  
 Rose, H. M., Ragan, C., Pearce, E., and Lipman, M. O. (1948). *Proc. Soc. exp. Biol. (N.Y.)*, 68, 1.  
 Stocks, P. (1949). "Sickness in the Population in England and Wales in 1944-1947." General Register Office, Studies on Medical and Population Subjects, No. 2. H.M.S.O., London.  
 Woolsey, T. D. (1952). *Publ. Hlth Rep. (Wash.)*, 67, 505.

### Arthrite rhumatisme dans une population urbaine

#### RÉSUMÉ

(1) On rechercha les signes d'arthrite rhumatisme chez 481 sujets âgés de 55 à 64 ans d'une population urbaine. Tous furent soumis à l'examen clinique, radiologique et sérologique.

(2) L'arthrite rhumatisme de sévérité variable fut trouvée deux fois plus souvent chez les femmes que chez les hommes, mais les chiffres de la réaction d'agglutination des cellules de mouton furent également repartis entre les deux sexes. De même, un nombre égal d'hommes et de femmes manifesta des signes radiologiques d'arthrite rhumatisme.

(3) Dans 9 cas sur 10 un tableau clinique d'arthrite rhumatisme sévère fut confirmé par la radiographie, par la réaction d'agglutination ou par les deux. Cette confirmation devint plus rare au fur et à mesure que la sévérité clinique de la maladie diminua. Parmi 283 sujets sans manifestations cliniques d'arthrite rhumatisme, il y eut vingt avec des signes radiologiques et/ou sérologiques.

(4) La fréquence de l'arthrite rhumatisme sévère confirmée radiologiquement et/ou sérologiquement fut de 1% pour les hommes et de 3% pour les femmes, tandis que le pourcentage des cas avec toutes les formes cliniques, y compris ceux avec des antécédents personnels de polyarthrite, fut 11% et 27% respectivement. Une définition diagnostique précise est donc essentielle pour étudier la fréquence comparée de la maladie dans de différentes populations.

### Artritis reumatoide en una población urbana

#### SUMARIO

(1) Se investigaron las manifestaciones de artritis reumatoide en 481 sujetos de 55 a 64 años de edad, de una población urbana. Todos ellos fueron sometidos al examen clínico, radiológico y sérologico.

(2) La artritis reumatoide de severidad variable fue encontrada dos veces más a menudo en mujeres que en hombres, pero las cifras de la reacción de aglutinación de células de oveja se repartieron igualmente entre cada sexo. Asimismo, un número igual de hombres y de mujeres tuvo manifestaciones radiológicas de artritis reumatoide.

(3) Sobre 10 casos de artritis reumatoide clínicamente severa, 9 presentaron una confirmación radiológica, serológica o ambas. Tal confirmación fue más rara en casos más benignos. Entre 283 sujetos sin manifestaciones clínicas de artritis reumatoide hubo veinte con signos radiológicos, serológicos o ambos.

(4) La frecuencia de la artritis reumatoide severa y confirmada radiológica y/o serológicamente fue de 1% de los hombres y de 3% de las mujeres, mientras que el porcentaje de los casos con todas las formas clínicas, incluyendo aquellos con antecedentes personales de poliartritis, fue de 11% y de 27% respectivamente. Una definición diagnóstica precisa es, pues, esencial para estudiar la frecuencia comparada de la enfermedad en diferentes poblaciones.