NEW HAVEN SURVEY OF JOINT DISEASES XVI IMPAIRMENT, DISABILITY, AND ARTHRITIS

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Over the past two decades epidemiologists interested in chronic illness have tended to concentrate on conditions which are lethal, and they have generally directed more attention to the elucidation of the causes of such diseases than to their social consequences. Although this work has been of great importance, one result is that we know less than we should about the burden on society of many diseases, especially those with a low case fatality rate such as the arthritides, varicosities, and even diabetes.

To date one of the few large-scale sources of information of this kind is in the United States where the National Health Examination Survey (1966a and b, 1968) has shown that the prevalence of arthritic conditions is extremely high, although it has not included data on impairment and disability in objectively ascertained cases. In contrast, the US National Health Interview Survey (1960, 1964, 1969, 1971), which has had to depend on the respondent's word for ascertainment of diagnosis, has collected data on the extent of limitations of activity. Throughout that country arthritis and rheumatism, which are treated in the National Health Survey as a single category, were by far the most serious cause of limited mobility, and in many areas they are also the most important chronic cause of limited activity (US National Health Survey, 1971). If arthritis and rheumatism are taken in combination with impairments of the spine, hips, and legs, they have consistently, between 1961 and 1967, accounted for 29% of all cases of limited activity and in this respect far outstrip in importance any other group of chronic diseases. Over the same seven-year period the next most important conditions have been those of the cardiovascular system, yet 'heart conditions' and 'hypertension without heart involvement' taken together have accounted for only 22% to 23% of the cases of chronically limited activity (US National Health Survey, 1968). In 1967 some 3,250,000 civilians who were not in hospitals or other institutions suffered limitation of activity

because of these two conditions and in well over half of these there was serious loss of time at work (US National Health Survey, 1971). The communal problem of arthritis and rheumatism is accentuated by the fact that the burden imposed by them is heaviest among the poorest members of the community. In Britain the General Household Survey is collecting data which are similar to those from the US Interview Survey (1964, 1969, 1971).

This paper presents some information about the interrelationship between impairment and disability and arthritic conditions in a group of adults from the general population of New Haven, Connecticut, and combines objective with interview data.

METHODS

POPULATION

These data were collected during the New Haven Survey of Joint Diseases. The survey was planned in several stages, data collection taking place from December 1963 to March 1967. Details of the study design have been given in earlier publications (Acheson, 1968; Acheson, Chan, and Payne, 1969; Acheson, von Stein, and Kelsey, 1972). Briefly, six areas of the City of New Haven, which represented different socio-economic strata, were selected for study, and attempts were made to interview all persons 21 years or older in each area (Acheson, 1968). A total of 2,199 people, about 92% of the target population, completed an initial interview. The age and sex distribution of these people is given in Table I. Of these, 1,475 persons cooperated in a later phase of the survey in which a questionnaire on disability was administered.

SELF-ASSESSED DISABILITY

Relevant parts of the questionnaire on disability are given in Table II. Following a few preliminary questions of a demographic nature, the respondents

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TABLE I

DISTRIBUTION OF STUDY POPULATION BY SEX, AGE, AND PARTICIPATION IN VARIOUS STAGES OF SURVEY

Sex	Age	No. completed Initial Interview	No. completed Interview on Disability	No. with MS or NP in Interview on Disability	No. with MS or NP and with radiographs	
					Hands and Wrists	Feet and Ankles
Male	<50 yr	508	339	97	80	80
Male	≥50 yr	439	296	106	87	86
Female	<50 yr	706	483	165	141	137
Female	≥50 yr	539	357	164	129	126
Unknown age	..	7**				
Total	..	2,199	1,475	532	437	429

MS = morning stiffness;

NP = nocturnal pain;

** Excluded from subsequent analyses

TABLE II

QUESTIONS ASKED ABOUT DISABILITY OF RESPONDENTS WHO COMPLAINED OF STIFFNESS AND/OR PAIN IN THE JOINTS

In the last three months has joint pain or stiffness caused you difficulty in?

Buttoning—unbuttoning	Arising from a chair
Telephone dialling	Walking
Pressing doorbell or working light switch	Climbing stairs
Opening lock with key	Scratching your back
Grasping a spoon	Turning over in bed
Using a hammer ¹	Twisting spine
Mixing in a bowl ²	Picking up box from floor
Carrying	Operating foot pedals in car

¹ Asked only of male respondents² Asked only of female respondents

were asked if they had felt morning stiffness or nocturnal pain during the three months before the interview. The 532 persons who admitted to having either of these symptoms were then asked if, in this same three months, either symptom had caused them difficulty in performing certain everyday tasks, ranging from buttoning and unbuttoning to picking up an object from the floor. Data obtained from these 532 people are used in this analysis.

IMPAIRMENT

At the end of the interview, measurement was made with a goniometer of the range of motion of the left metacarpophalangeal joint and of the wrist (Fig. 1). The left hand was chosen because it was thought to be less susceptible to trauma. This measurement provided an objective indicator of reduction of movement associated with joint diseases. At an earlier stage of the survey, postero-anterior radiographs of both hands and wrists and of both feet and ankles had been taken.

ASSESSMENT OF RADIOGRAPHS

These radiographs were read by a radiologist, and each joint was graded for osteoarthrotic changes

FIG. 1. Measurement of flexion of the fingers at the metacarpophalangeal joints with a goniometer. A second reading was taken with the fingers fully extended, and range of motion was determined by subtraction.

on a scale of 0-4 in accordance with the *Atlas of Standard Radiographs of Arthritis* (Kellgren and Lawrence, 1963). Of the total of 532 persons with symptoms, satisfactory films were obtained of the hands of 438 persons and of the feet of 429 persons. Three scores or indices indicating osteoarthrosis were calculated for the hands and for the feet using the formulae of Wright, Mikkelsen, and Dodge (1971).

The first, index A, is the total score for all the joints of a hand or foot divided by the number of joints which the radiologist considered to be legible*. Since either severe disease in a few joints, or more moderate disease in the many joints, can produce the same mean score, indices I and G were calculated to provide measures of average intensity of arthrosis

* In some instances, amputation, flexion or other errors in posture made it impossible to visualize the joint space (Wright and Acheson, 1970).

and of the extensiveness of joint involvement throughout the hand or foot: index I differs from index A in that the denominator is the number of joints graded one or more rather than the total number of joints. In index G the total score is multiplied by the number of joints graded 1 or more.

ANALYSES

Thus, impairment and disability were measured subjectively by questionnaire and objectively in the hand with a goniometer; both could be compared with the intensity of the disease as visualized from radiographs and subjective information on disability could be compared with scores derived from reading radiographs of the hands and feet. For the analysis of data pertaining to the hands, the tasks have been divided into three groups, as shown in the left-hand column of Table III. The first group comprises tasks which require use of the hands and wrists primarily; the second, tasks which involve other parts of the body as well as the hands and wrists; and the third, tasks in which the hands and wrists do not ordinarily play a role. For the analysis of data pertaining to the feet, the tasks were divided into two groups: first, tasks involving some use of the feet, including arising from a chair, walking, climbing stairs, carrying and using foot pedals; and second, tasks which ordinarily do not require use of the feet. In Fig. 2, the first two tasks belong to the latter group, the next two to the former. The study population was divided into four age and sex specific groups: males below age 50, males aged 50 and over, females below age 50 and females aged 50 and over.

Fig. 2. Association between stated difficulty in performing certain tasks and morning stiffness of the feet.

RESULTS

SYMPTOMS OF DISABILITY BY AGE AND SEX OF RESPONDENTS WHO COMPLAIN OF HAVING DIFFICULTY IN PERFORMING THE VARIOUS TASKS

Table III shows the proportions of respondents who complain of having difficulty in performing the various tasks in the entire study population of 532. The sexes are treated separately and each is divided into those under and those 50 years of age and over. It can be seen that in men the prevalence of disability rises with age; with the exception of mixing, carrying, and turning in bed, this is also true for women. It can also be seen that, with a few exceptions, disability in this symptomatic population tends to be commoner in women than in men.

Table IV presents data which compare the disability of persons who said that they had stiffness in the hands with those in whom there were no symptoms in the hands although they existed elsewhere in the body. Comparisons are made by age and sex.

It can be seen that among persons having stiffness in the hands there are three consistent trends. First, the percentage of those who consider themselves to be disabled increases with age; second, with one exception, the percentages are higher on an age specific basis in women than in men and, third, they are greater among those with symptoms in the hands than among those without them in the hands.

TABLE III
PERCENTAGES OF PERSONS HAVING DIFFICULTY WITH EVERYDAY TASKS BY AGE AND SEX

Difficulty	Males		Females	
	Age (yr)		Age (yr)	
	< 50	≥ 50	< 50	≥ 50
GROUP I	%	%	%	%
Buttoning-unbuttoning ..	4.1	15.0	12.8	22.6
Using a key ..	1.3	8.7	5.1	6.9
Grasping a spoon ..	1.3	11.2	5.9	9.5
Using a hammer ..	8.2	11.2		
Mixing in a bowl ..			13.6	13.0
GROUP II				
Scratching back ..	9.5	21.2	14.5	25.2
Picking up box from floor ..	32.8	36.2	29.9	32.1
Carrying ..	8.2	15.0	22.2	21.7
GROUP III				
Arising from a chair ..	23.2	57.5	27.3	53.9
Walking ..	24.6	38.7	23.9	36.5
Climbing stairs ..	20.5	32.5	26.5	44.3
Turning over in bed ..	17.8	31.2	31.6	31.3
Twisting spine ..	20.5	25.0	22.2	22.6
Mean ..	14.3	25.3	19.6	26.6
N ..	73	80	117	115

TABLE IV

PERCENTAGES OF PERSONS WITH MORNING STIFFNESS HAVING DIFFICULTIES WITH EVERYDAY TASKS ACCORDING TO WHETHER OR NOT MORNING STIFFNESS (MS) WAS PRESENT IN HANDS, BY SEX AND AGE (N = 385)

Difficulty*	Males <50 yr		Males ≥50 yr		Females <50 yr		Females ≥50 yr	
	MS in hands		MS in hands		MS in hands		MS in hands	
	Present	Absent	Present	Absent	Present	Absent	Present	Absent
	%	%	%	%	%	%	%	%
GROUP I								
Buttoning—unbuttoning ..	9.5	1.9	31.3	10.9	28.6	6.1	36.0	12.3
Using a key ..	4.8	0	18.7	6.3	11.4	2.4	10.4	4.6
Grasping a spoon ..	5.3	0	31.3	6.5	11.4	3.7	16.8	4.7
Using a hammer ..	16.7	3.9	31.3	6.5				
Mixing in a bowl ..					25.7	8.7	19.5	7.7
GROUP II								
Scratching back ..	9.5	9.6	31.3	19.0	25.7	9.8	28.7	23.1
Picking up box from floor ..	33.3	34.6	43.7	33.9	28.6	30.5	36.8	29.7
Carrying ..	21.1	4.0	31.3	10.9	29.4	19.8	28.3	17.5
GROUP III								
Arising from a chair ..	19.0	25.0	43.7	56.3	20.0	30.9	52.2	55.4
Walking ..	28.6	23.1	50.0	35.9	14.3	28.0	38.3	40.0
Climbing stairs ..	14.3	23.0	43.7	29.7	28.6	25.6	44.3	46.2
Turning over in bed ..	14.3	19.2	25.0	33.3	28.6	32.9	33.0	30.8
Twisting spine ..	19.0	21.2	18.7	27.0	20.0	23.5	28.9	18.7
n ..	21	52	16	64	35	82	50	65

* Telephone dialling, pressing doorbell, working light switch, and operating foot pedals in a car are excluded because of the small numbers of people having difficulties with them.

For instance, 9.5% of males under 50 years of age with stiffness in their hands had difficulty buttoning and unbuttoning compared with 1.9% of those without stiffness in that part of the body. Among males of age 50 and older, the corresponding percentages are 31.3 and 10.9, for younger females, 28.6 and 6.1, and for older females, 36.0 and 12.3.

For tasks in which the hands and wrists are used along with other parts of the body (group II), the trends are not quite so consistent but are in the same direction, except among the younger males who show no clear association between dysfunction and symptoms. For tasks in which the hands and wrists are ordinarily not used, the age and sex differences are fairly consistent, but there are no differences between those who do and do not have stiffness symptoms.

Figure 2 and subsequent figures summarize data similar to those shown in Table IV*. Fig. 2 indicates that, among the four age and sex specific groups, persons having stiffness in their feet had more difficulty with tasks requiring use of the feet (arising from a chair and walking) than those whose feet were asymptomatic. The results are thus similar to those shown in Table II. Among females of both age groups, the same trend is found in the group of tasks which do not involve the feet. However, the numbers with stiffness in their feet are very small. The data for the symptom of nocturnal pain in the hands and in the feet demonstrate the same trends, and therefore are not presented here.

* Results for the greater part of the analysis are presented in graphic form for ease of interpretation. The detailed data may be obtained by writing to R.M.A.

Thus, not surprisingly, those with symptoms of joint disease in the hands or feet complain more frequently of difficulties in performing daily tasks which involve those body areas than do those whose symptoms of joint disease are elsewhere in the body.

SYMPTOMS OF DISABILITY AND SIGNS OF ARTHROSIS

The next question to be considered was whether persons with radiological evidence of extensive osteoarthritis in the hands and feet experienced more difficulty in managing such tasks than those with normal joints. For this purpose each age-sex specific group was divided on the basis of the median x-ray score into two subgroups which were as nearly equal in number as possible. As indicated by Fig. 3, among the younger males there is a higher percentage of those with scores for osteoarthritis above the median who had difficulties with tasks involving the hands; for the other two tasks differences were small. Among the older males, although the prevalence of difficulties was greater, the trend was in the opposite direction.

Females showed an association between higher x-ray score and greater likelihood of having difficulty with tasks in all the sex subgroups. The association between osteoarthritis and disability is thus greater in women than in men. Similar patterns were observed with all three indices, A, I, and G; they were slightly more marked when the I index provided the basis of the analysis for hand tasks, and for other tasks when the G index was used. However, the I indices are used throughout in Figs. 3 and 4.

FIG. 3. Association between stated difficulty in performing certain tasks and severity of osteoarthritis of the hands in radiograph (I Index).

FIG. 4. Association between stated difficulty in performing certain tasks and severity of osteoarthritis of the feet in radiograph (I Index).

The association between osteoarthritis of the feet and difficulty with the tasks is similar to that for the hands (see Fig. 4). In six instances out of eight there was some tendency for there to be an association between arthrosis on the radiograph and disability in women. Whereas, with a single exception, no such association is to be found in men.

FIG. 5. Association between stated difficulty in performing certain tasks and range of motion of the metacarpophalangeal joints of the left hand.

These patterns tended to be more consistent and slightly greater when based on the index I—the results for which are shown.

Symptoms of Disability and Signs of Impairment

Next we compared difficulty in performing tasks and signs of impaired movement at the knuckles of the left hand (see Fig. 5).

In the older age group in both sexes, those with a smaller range of motion said they had more difficulties with all of these tasks than did those with a larger range of motion. There was no marked difference between the sexes.

In the younger age group these trends are in the same direction among the males but in two instances in females they are in the opposite direction. These selected examples represent fairly the larger body of data from which they are drawn, and this is the only analysis which suggests a less consistent relationship between impairment, disability, and symptoms of joint disease in young women than in young men.

Signs of Arthrosis and Symptoms of Disability

Finally, we studied the association between objective measurement of joint disease and range of motion, and the results are given in Fig. 6. Since range of motion measurements were made on the left fingers (see Fig. 1), these are compared with scores for osteoarthritis of the left hand only. As for the analyses illustrated in Figs. 3 and 4, each age and sex specific group was divided on the basis of

(One woman under 50 had RA, all other cases were OA)

FIG. 6. Association between arthritis of metacarpophalangeal joints in radiographs and range of motion of those joints.

the median x-ray score for the whole group, and comparison was made between those above, and those at or below, the median. It can be seen in Fig. 6 that for three age-sex groups, the exception being the older males, those considered by a radiologist to have severe joint disease make up a greater proportion of the group with limited range of motion than those in whom disease is mild or absent. In no sex or age specific group do more than 35% of people with limited motion at the metacarpophalangeal joint have osteoarthritis scores in the severe category, so that at least 65% of the people who could move their metacarpophalangeal joints through less than 90° have only mild osteoarthritis. Although the severity and prevalence of osteoarthritis of the knuckles was greater in males than females (Acheson, Chan, and Clemett, 1970), the association of the disease with restricted movement was greater in females.

DISCUSSION

As Table I indicates, it would be hazardous to attempt to estimate the prevalence of disability from these data. Information is available about only a relatively small proportion of the original target population, and there is no reason to suppose that those for whom it is available constitute a random sample of the total study group. Nevertheless, within themselves the data are reasonably

consistent, and it is probably justifiable to draw some general conclusions about the nature and effects of osteoarthritis from them.

Three of the findings warrant comment. First, it is not surprising that people with signs or symptoms of the hands or feet experience problems in activities involving either. It is, however, of interest that those with radiological signs of osteoarthritis which are confined to the hands or the feet, or with limitation of movement in the hands, tend to have more difficulty than other people with morning stiffness and nocturnal joint pain in performing tasks involving the trunk and legs. This finding supports the view that osteoarthritis is frequently a generalized disease (Kellgren and Moore, 1952).

Second, the data are fairly consistent in indicating that osteoarthritis affects the sexes differently. Other reports from the New Haven Survey have shown that morning stiffness, nocturnal joint pain, and swelling of the joints are more frequent in women than in men when each occurs separately, that all three occur simultaneously in women more often, and that if any occurs in one site it is more likely to occur in several sites in women (Acheson, Chan, and Payne, 1969). It was also found that if any of these three symptoms occurred in the hands there was more likely to be concomitant radiologically diagnosed osteoarthritis in women than in men (Acheson *et al.*, 1970). It is true that with the exception of the knuckles, osteoarthritis tends to be rather more frequent and more severe in the hands in women than in men (US National Health Survey, 1966 a and b; Acheson *et al.*, 1970) but there is more to the sex differences. Given an osteoarthrotic finger joint, this is both more likely to give rise to symptoms and to show enlargement measured objectively in a woman than in a man, and in women the association between joint enlargement and age is much more marked than in men (Acheson, von Stein, and Kelsey, 1972). The present data provide further information about the extent of these sex differences. It is shown here (Table III) that a slightly larger proportion of the women than the men in both age groups have trouble with performing daily tasks. Women with severe or extensive radiological osteoarthritis of the hands or feet are more likely to have trouble with the tasks than men with x-ray evidence of severe disease—though there is no clear sex-relationship between problems with tasks and mild disease. Reduction of movement also has a greater tendency to be associated with joint disease in women than in men. No direct comparison can be made between the present data and the published reports of the

US National Health Survey, although one of the earliest of these compared the amount of limited activity in men and women who said they had arthritis and rheumatism, but showed no difference (US National Health Survey, 1960). It is probably fair to assume that the internal consistency of the New Haven data in showing a difference between the sexes in the natural history of the disease has some aetiological significance; this may or may not have a hormonal basis.

We have already referred to data which show that the prevalence of osteoarthritis increases rapidly with age. The closeness of this association is evident from the fact that age is a more effective predictor of who, in the general population, has osteoarthritis of the fingers, than a variety of clinical characteristics seen on a standardized coloured photograph (Acheson, Collart, and Greenberg, 1969). The New Haven data indicate that not only osteoarthritis itself, but the prevalence of many signs and symptoms including disability, objectively measured impairment of movement at the metacarpophalangeal joints, the presence of morning stiffness, and joint swelling, also become more frequent with increasing age, even when there is no radiological evidence of severe or extensive osteoarthritis or of rheumatoid arthritis in the hands or feet.

It is common knowledge that none of the tasks considered in this analysis presents problems to the arthritic only. Some, such as buttoning and unbuttoning, are awkward for people with a variety of neurological or muscular conditions; difficulty with others, such as climbing the stairs, is experienced by people with these conditions as well as others with diseases of the heart and of the lungs. It was in an attempt to overcome this lack of specificity that each respondent was asked whether he attributed the difficulty he experienced with tasks to joint disease (see Fig. 2). Little impairment of disability can be attributed to rheumatoid arthritis in this population, however, because, as Table IV shows, there was only one respondent with radiological evidence of this disease, and in the subsample which was examined clinically, there were only a few others who satisfied the New York criteria for rheumatoid arthritis (Bennett and Wood, 1968). This leads to our third point, which is that although osteoarthritis is far and away the most common form of joint disease, and although it causes much impairment and disability, there is evidently much relatively minor joint disease which, within the limitations of the diagnostic techniques of this survey, can only be called nonspecific.

More cases could have been labelled by the American Rheumatism Association criteria as mild rheumatoid arthritis; that these criteria permit the identification of any specific disease entity has, however, been seriously questioned (Acheson, 1965; Bennett and Wood, 1968).

These data cannot satisfactorily be compared directly with those collected in the National Health Survey (1960, 1966 a and b, 1968, 1971). There are a variety of reasons for this. For instance, the study group considered in this paper does not constitute a probability sample of the general population; National Health Survey data do not express results in terms of the prevalence of disability in persons complaining of a certain disease; and, of course, diagnoses based on interview data are much less reliable than those based on medical examination *x-ray* diagnoses. The survey did, however, show that from middle age onwards the most objective and probably the most specific of all evidence of joint disease, namely *x-ray* changes, have a prevalence of 10-20% among the middle-aged and older members of the general population. The present data, together with other reports from the New Haven Survey (Elder, 1968; Elder and Acheson, 1970), suggest that the prevalence of limitation of movement at certain joints in the hand, and the experience of having difficulty in performing some simple everyday tasks, may be more or less of an equal order of magnitude. The interrelationship between the three is by no means one to one, but it is of sufficient order to support the view that generalized osteoarthritis, together with non-specific arthritis, cause discomfort and inconvenience extensively in the community.

SUMMARY

In a survey of a sample of the general population of New Haven, Connecticut, 532 people said that they had morning stiffness, or nocturnal pain, of their joints. Each was asked whether joint disease caused difficulty in specified everyday tasks. Range of motion in the fingers and at the wrist was measured, and joints with arthritic changes in the hands and feet were identified by radiograph.

A larger proportion of the women than of the men experienced difficulty in performing these daily tasks. In both sexes this proportion was greater in those over than in those under 50 years of age.

In both sexes and in both age groups there was an association between stiffness or pain in the hands or feet and difficulty in performing tasks involving those parts of the body.

Women with x-ray evidence of extensive osteoarthritis in the hands or feet were in general more likely to complain of difficulty in daily tasks than women without such evidence. There was no clearcut relationship between x-ray changes and difficulty with tasks in men.

In older people of both sexes, those who said they had difficulty with daily tasks had a lower range of motion at the knuckles of the left hand than those who did not have such difficulty. There was a similar but weaker trend between these two variables under age 50 in men but not in women.

Women in both age groups, and the younger men with radiological evidence of extensive osteoarthritis in the left hand, had a lower range of motion at the left metacarpophalangeal joint than those without extensive x-ray disease. There was no relationship between range of motion and x-ray disease in the older men.

The data do not permit exact estimates of the prevalence of disability to be made. They do, however, suggest that the burden of minor discomfort and inconvenience caused by arthritis in general and osteoarthritis in particular is considerable. They are also consistent with the view that osteoarthritis affects the sexes differently.

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unlikely to die in the near future; up to about a hundred could still be in hospital in 10 years' time, in the absence of any alternative provision.

It is still official policy to work towards the eventual closure of the large separate mental hospitals (Department of Health and Social Security, 1971), although it is now recognized that this will not be feasible in the very near future. The DHSS memorandum "Services for mental illness related to old age" (DHSS, 1972) deals with patients who have grown old in mental hospitals as a special group. Regular re-assessment is essential for these patients, and 'care should be taken to transfer patients, wherever possible, with the staff to whom they are accustomed and to an environment similar to that which they have left'. The question becomes one of providing appropriate and adequate alternatives for both elderly chronic patients and those who are not yet old but have been in hospital for many years.

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CORRECTION

In the August issue of the journal, the authors of the paper on p.168, 'New Haven Survey of Joint Diseases XVI. Impairment, Disability, and Arthritis', are Roy M. Acheson, Jennifer L. Kelsey, and Gerald N. Ginsburg.