British Journal of Industrial Medicine 1987;44:602–610

Prevalence rates and odds ratios of shoulder-neck diseases in different occupational groups

M HAGBERG,[1] D H WEGMAN[2]

From the National Board of Occupational Safety and Health,[1] Medical Division, Umeå, Sweden, and School of Public Health,[2] Division of Environmental and Occupational Health Sciences, University of California, Los Angeles, USA

ABSTRACT The aim of the present study was to evaluate the association and impact of occupational exposure and diseases of the shoulder and neck. Prevalence rates, odds ratios, aetiological fractions, and their confidence intervals were computed for pooled and non-pooled data of previous published reports. By comparison with office workers and farmers, dentists had an increased odds ratio for cervical spondylosis (two studies) and for shoulder joint osteoarthrosis. Meat carriers, miners, and "heavy workers" also had significantly higher rates of cervical spondylosis compared with referents. Compared with iron foundry workers, civil servants had a significant odds ratio (4·8) of cervical disc disease and a 0·79 aetiological fraction. Whether this was due to exposure or healthy worker effect was not clear. In four occupational groups with high shoulder-neck load an odds ratio of 4·0 was found for thoracic outlet syndrome with an aetiological fraction of 0·75. Rotator cuff tendinitis in occupational groups with work at shoulder level (two studies) showed an odds ratio of 11 and an aetiological fraction of 0·91. Keyboard operators had an odds ratio of 3·0 for tension neck syndrome (five studies). Unfortunately, owing to the scanty description of the work task, the exposure could be analysed only by job title. Examination of published reports shows clearly that certain job titles are associated with shoulder-neck disorders. High rates and aetiological fractions for rotator cuff tendinitis and tension neck syndrome suggest that preventive measures could be effective. Although job descriptions are brief, the associations noted suggest that highly repetitive shoulder muscle contractions, static contractions, and work at shoulder level are hazardous exposure factors. In reports of cross sectional studies of occupational shoulder-neck disorders presentation of age, exposure, and effect distribution may help for future meta-analysis.

In 1977 Hadler stated that the exposure effect relations of regional musculoskeletal diseases in industry are almost entirely anecdotal, although musculoskeletal diseases rank first in cost to worker's compensation insurance carriers in the United States.[1 2] In recent years evidence of an increasing problem with job related shoulder-neck disorders has been reported from Japan and Scandinavia.[3 4] This is regarded as a consequence of constrained work postures and repetitive work tasks in industry. An excellent review of occupational cervicobrachial syndromes was published by Waris in 1979, dealing particularly with definition, aetiology, and pathogenesis.[5] Most epidemiological studies regarding occupational shoulder-neck disorders, however, are cross sectional and present only prevalence rates. Comparisons with referent groups are often made with no basic epidemiological analysis. The aim of the present investigation was to evaluate the prevalence of shoulder-neck diseases in different occupations presented in previous published studies by calculating prevalence odds ratios, aetiological fractions, and their confidence intervals. Furthermore, several grouped stratified analyses (pooling) was attempted.

Accepted 29 September 1986

Methods

A survey of the Medlars documentation system was performed for the years between 1966 and 1986 (April); 178 references to occupational shoulder-neck disorders were obtained. Of these, only 20% contained information of an epidemiological nature. Additional references earlier than 1966 have been gathered by studying reference lists. In the present investigation we have considered only the 21 articles

Table 1 *Study base characteristics, occupational groups job title, sex, age, source—reference number*

Occupational group	*Sex*	*No*	*Mean age*	*Referents*	*Sex*	*No*	*Mean age*	*Ref No*
Miners	M	84	45*	Office workers	M	42	45*	6
Manual workers	M	45	45*	Office workers	M	42	45*	6
"Heavy workers": Stevedores, slaughterhouse workers, meat packers, construction workers, foundry workers, metal workers	M	657	43*	"Light workers": Shop assistants, light industrial workers, sedentary workers	M	466	41	7
Miners	M	84	51	Office workers	M	113	51	8
Carriers	M	100	56					8
Dentists	M	100	56					8
Cotton workers	M	113	57*	General population	M	115	57	9
Cotton workers	F	222	55*	General population	M	223	55	9
Miners	M	74	45*	"Other men"	M	55	46*	10
Iron foundry workers	M	858	44*					11
Dockers	M	215	47*	Civil servants	M	188	39	12
Stenotypists	F	100	55	Office workers	F	100	57	13
Meat carriers	M	54	40	Industrial workers	M	100	43	14
Lamp assemblers	F	95	21	Teachers and nurses of handicapped children	F	46	27	15
Film rolling workers	F	109	25					15
Office workers	F	74	25					15
Industrial workers working at or above shoulder level	M	17	53	Industrial workers working below shoulder level	M	34	53	16
Assembly line packers	F	152	39	Shop assistants	F	133	39	17
Light mechanical industrial workers, scissors makers	F† (3 men in group)	93	32					18
Shipyard welders	M	131	39	Office workers	M	57	?	19
Data entry operators	F† (3 men in group)	53	30	Office workers	F/M	55	28	20
Conversational terminal operators	M/F (54 men in group)	109	34	Office workers	F/M	55	28	20
Typists	F† (4 men in group)	78	34	Office workers	F/M	55	28	20
Data entry workers	F	104	29	Office workers	F	57	31	21
Slaughterhouse workers	M† (31 women in group)	113	32					22
Plate workers	M	188	39	Office workers	M	57	?	23
Cash register operators	F	37	36	Office workers	F	35	31	24
Assembly line workers	F	9	29	Office workers	F	35	31	24
Assembly line workers	M	83	36	Office workers	M	27	36	24
Dentists	M	119	46*	Farmers	M	192	46	25
Industrial workers	M	287	39	Industrial workers	M	287	39	26

*Age estimated from frequency tables.
†Small number of opposite sex in group.

where the study groups had a diagnosis of shoulder-neck disorder that included a physical or laboratory examination (table 1). From each article the prevalence rate of the disease has been compared with that of the referent group given by the author(s). The prevalence rates are expressed as the number of cases per 100 in the groups.

The effects of exposure (usually defined by job title) have been measured by the prevalence odds ratio, the prevalence odds being the probability of being a case divided by the probability of not being a case. The prevalence odds ratio represents an estimate of the incidence rate ratio if the mean duration of disease is identical in the exposed and the non-exposed.[27] For the prevalence rate ratios, the 95% confidence intervals were also computed.

If stratified analysis was possible a standardised odds ratio (SOR) was calculated according to Miettinen[28] and the 95% confidence interval according to Greenland.[29] These odds ratios were standardised for age or "study", or both, by using the exposed group as the standard population.[27] A test of heterogeneity of effect across studies was made using the method described by Woolfe.[30]

The impact of the exposure (job title) was estimated by the aetiological fraction in the exposed population—that is, the proportion of exposed cases attributable to exposure. The aetiological fraction and its confidence interval was estimated by (OR-1)/OR, where OR is the estimated odds ratio.[27] In the standardised analyses the SOR was substituted for the OR in the expression for the aetiological fraction. The confidence limits for the aetiological fraction estimates were computed from the estimated variance of the natural log of the SOR.[31] To analyse data when zero cells were present, 0·5 was added to each cell.

The diagnostic criteria used for the shoulder-neck disorders varied in the examined studies. A brief description of the different diagnostic criteria is outlined below.

CERVICAL SPONDYLOSIS

The diagnosis of cervical spondylosis was based on *x* ray examination only. Degenerative change of the cervical spine, here termed cervical spondylosis, is characterised by reduced disc height, indicating disc degeneration, and by proliferation of bone tissue (spurs or osteophytes). Hult includes osteophytes as a sign of disc degeneration.[7] Lawrence distinguishes between osteoarthrosis and disc degeneration of the cervical spine.[9] We regard osteoarthrosis in the cervical spine as spondylosis. For the early studies of Schroter severe "osteochondrose und spondylose" have been analysed as spondylosis according to the analysis performed by the author.[8 13] As the report on meat carriers presented only frequencies of spondylosis for each cervical level we computed the odds ratio standardised to cervical level. In summary our concept of cervical spondylosis is that of degenerative changes in the cervical spine, radiographically seen as spurs or a reduction in disc height.

CERVICAL SYNDROME (cervical disc disease)

The diagnosis of cervical syndrome was based on interview and physical examination. Dockers, civil servants,[12] and iron foundry workers[11] had an interview about musculoskeletal pain. When symptoms were present a simple clinical examination was made to localise the site and cause of the pain.[32] Pain had to be present in the neck, radiating along the distribution of a spinal root at some time. For assembly line packers, shop assistants, slaughterhouse workers, scissors makers, and data entry operators the diagnostic criteria were neck pain radiating to one or both arms and numbness in the hands in addition to limitation of neck movement and radiating pain provoked by test movements.[33] Pain in the neck radiating to the arm with a segmental distribution was our concept of cervical syndrome.

THORACIC OUTLET SYNDROME (TOS)

Cash register operators, assembly workers, and their referents were diagnosed as having symptoms of TOS if the abduction external rotation test (Roos's test[34]) was positive.[24] Positives were those who experienced pain, early fatigue, tingling, or paraesthesias during the three minute test. Tenderness over the brachial plexus in the supraclavicular fossa was also sought. Whether both symptoms in the test and tenderness of the brachial plexus or either one was needed for the classification "symptoms of TOS" is not stated in the article.[24] For assembly line packers, shop assistants, and scissors makers the diagnostic criteria were subjective symptoms of pain radiating in the hand and a positive Moreley's sign (tenderness in the supraclavicular fossa). In addition, drooping shoulder or Adson's test (radial pulse impairment or loss on head rotation) had to be present.[33] The criteria used in the examination of slaughterhouse workers were pain radiating to hand and a positive Roos's test. In the study of Silverstein the criteria were paraesthesias (usually in the ulnar distribution in hand and arm), positive Adson, hyperabduction or costoclavicular test, and decreased grip strength. In summary, the concept of TOS is that of a compression of the neurovascular bundle at the shoulder-thoracal junction. The criteria differ among researchers as to the type and number of clinical tests that have to be positive. We have included in TOS a positive Roos's test as a single criterion which may be an early and sensitive indicator even though the specificity of the test is low.

SHOULDER JOINT OSTEOARTHROSIS

This diagnosis was based solely on *x* ray findings. The criteria of shoulder joint changes were not presented in the only article concerned with this disease.[25] Our concept of shoulder joint osteoarthrosis is that of a reduction in the articular cartilage height and sclerosis in the structures of the glenohumeral joint.

ROTATOR CUFF TENDINITIS (supraspinous tendinitis)

Shipyard welders, plate workers, and male office workers had the following criteria for supraspinous tendinitis: localised shoulder pain and tenderness of the humeral head. Pain with isometric contractions, limitations of active range of movement, and reduction of gross power were measured but it is not stated whether these signs were required for the diagnosis.[19 23] For slaughterhouse workers the diagnostic criteria were pain in the shoulder region and local tenderness.[22] The criteria for scissors makers, assembly line packers, and data entry operators were local pain, local tenderness, pain during abduction, and limited active abduction.[33] In the case-referent study of industrial workers working with the hands at or above shoulder level the criteria were local pain and tenderness in addition to pain at isometric abduction.[16] In summary, rotator cuff tendinitis was regarded as localised shoulder pain with tenderness over the humeral head.

TENSION NECK SYNDROME

A constant feeling of fatigue or stiffness, or both, in the neck plus one more subjective symptom—for example, neck pain or headache in addition to signs of at least two tender spots or palpable hardenings, or both, plus muscle tightness in neck movements—were the diagnostic criteria of tension neck syndrome for the Finnish studies of slaughterhouse workers, data entry operators, assembly line packers, shop assistants, and female office workers.[33] For the Swiss data

Table 2 *Cervical spondylosis. Prevalence rates (number of cases per 100 in group) and odds ratios of radiographically verified degenerative changes in the cervical spine*

Occupational group	*Sex*	*R1*	*R0*	*OR*	*95 CI*	*EF*	*95 CI*	*Ref No*
Meat carriers	M	84	33	8·4	4·5–16	0·88	0·74–0·94	14
Dentists	M	42	14	5·3*	2·7–10	0·81	0·63–0·90	8
Miners	M	76	51	4·5*	1·5–13	0·78	0·34–0·92	10
Dentists	M	50	31	4·0	2·0–7·9	0·75	0·50–0·87	25
Miners	M	54	38	1·9	0·89–2·8			6
Heavy workers	M	55	42	1·7*	1·2–2·3	0·40	0·16–0·57	7
Carriers	M	23	14	1·8	0·89–3·7			8
Manual workers	M	42	38	1·2	0·51–2·8			6
Miners	M	13	14	0·91	0·40–2·1			8
Cotton workers (osteoarthrosis)	F	31	38	0·75	0·50–1·1			9
Cotton workers (disc degeneration)	F	56	70	0·69	0·47–1·0			9
Cotton workers (osteoarthrosis)	M	41	53	0·61	0·63–1·0			9
Cotton workers (disc degeneration)	M	78	83	0·57	0·30–1·1			20

R1 = rate study group, R0 = rate referent group, OR = odds ratio, EF = aetiological fraction in exposed group, 95 CI = 95% confidence interval, Ref No = source as number in reference list.
*Age standardised odds ratio.

entry operators, "conversational terminal operators," typists, and office workers the medical finding listed as "tendomyotic pressure pains in shoulders and neck" was regarded as tension neck syndrome.[20] In the study of film rolling workers, lamp assemblers, office workers, teachers, and nurses of handicapped children by Onishi *et al*[15] we used the group who had shoulder stiffness in addition to tenderness threshold of the upper trapezius muscle up to 1·50 kg/cm^2 as having tension neck syndrome. Silverstein defined tension neck syndrome for industrial workers as neck pain or stiffness, muscle tightness, palpable hardenings, and tender spots.[26] Furthermore, pain on resisted neck lateral flexion and rotation was required. In summary our concept of tension neck syndrome was pain in the shoulder or neck in addition to tenderness over the descending part of the trapezius muscle.

POOLED STUDIES

The exposure in most studies was given only by job title or by industry.[16] For the scissors makers a job analysis was presented and a dose response analysis was carried out.[18] It was not possible, therefore, to group studies for exposure otherwise than by the type of job within each diagnostic group. The objective of grouping (pooling) studies was to evaluate the total effect and impact of exposure. This was done by standardised analysis controlling for variables such as age and sex when available. A serious limitation for this analysis was that the referent groups may have had unidentified differences in exposures. The male and female cotton workers with "osteoarthrosis" and disc degeneration were pooled into a group of cotton workers.[9]

Thoracic outlet syndrome—Occupational groups, where the work tasks were assumed to contain highly repetitive arm movements, were pooled into a group of "repetitive arm movement jobs." These four pooled occupational groups were assembly line packers, male and female assembly line workers, and cash register operators.[17 24]

Rotator cuff tendinitis—Two studies were pooled into a "shoulder level jobs" group,[19 23] since the workers had work tasks at or above shoulder level. These workers consisted of shipyard welders and plate workers.

Tension neck syndrome—A pooled group—"keyboard operators"—was created, consisting of four occupational groups of VDT operators and typists.[20 21]

Results

CERVICAL SPONDYLOSIS

Odds ratios significantly exceeding 1 were found for

Table 3 *Analysis of pooled studies*

Occupational group	*Effect*	*SOR*	*95 CI*	*EF*	*95 CI*	*Ref No*
Shoulder level jobs	Rotator cuff tendinitis	11	2·7–48	0·91	0·63–0·98	19, 23
Repetitive arm movements jobs	Thoracic outlet syndrome	4·0	1·2–13	0·75	0·18–0·92	17, 24
Keyboard operators	Tension neck syndrome	3·0	2·0–4·7	0·67	0·49–0·79	20, 21
Cotton workers	Cervical spondylosis	0·66	0·51–0·84			9

SOR, EF, 95 CI, Ref No, see table 2.
Heterogeneity test of effects across studies was non-significant for all studies.

Table 4 *Cervical syndrome. Prevalence rates (number of cases per 100 in group) and odds ratios of cervical syndrome (cervical disc disease). (Referents within parentheses not given by the original author of the study group)*

Occupational group	*Sex*	*Referents*	*R1*	*R0*	*OR*	*95 CI*	*EF*	*95 CI*	*Ref No*
Slaughterhouse workers	M	(Assembly line packers)	5	1	8·5	1·0–71	0·88	0–0·99	17, 22
Scissors makers	F	(Assembly line packers)	3	1	5·0	0·52–49			18, 22
Civil servants	M	(Iron foundry workers)	5	1	4·8*	1·8–13	0·79	0·44–0·92	11, 12
Data entry operators	F	Office workers	1	2	0·54	0·03–8·9			21
Dockers	M	Civil servants	2	5	0·47	0·14–1·5			12
Assembly line packers	F	Shop assistants	1	2	0·27	0·03–2·8			17
Iron foundry workers	M	(Civil servants)	1	5	0·07	0·02–0·26			11, 12

R1, R0, OR, 95 CI, EF, Ref No, *, see table 2.

Table 5 *Thoracic outlet syndrome. Prevalence rates (number of cases per 100 in group) and odds ratios for thoracic outlet syndrome (TOS). (Referents within parentheses not given by the original author of the study group)*

Occupational group	*Sex*	*Referents*	*R1*	*R0*	*OR*	*95 CI*	*Ref No*
Assembly line packers	F	Shop assistants	3	0	10	0·54–182	17
Assembly line workers	M	Office workers	14	0	9·6	0·55–168	24
Assembly line workers	F	Office workers	44	14	3·9	0·80–19	24
Slaughterhouse workers	M	(Scissors makers)	1	0	2·5	0·10–62	18, 22
Cash register operators	F	Office workers	32	17	1·7	0·54–5·3	24

R1, R0, OR, 95 CI, Ref No, see table 2.

Table 6 *Rotator cuff tendinitis. Prevalence rates (number of cases per 100 in study group) and odds ratios of rotator cuff tendinitis (supraspinate tendinitis). (Referents within parentheses not given by the original author of the study group)*

Occupational group	*Sex*	*Referents*	*R1*	*R0*	*OR*	*95 CI*	*EF*	*95 CI*	*Ref No*
Shipyard welders	M	Office workers	18	2	13	1·7–95	0·92	0·41–0·99	19
Plate workers	M	Office workers	16	2	11	1·5–83	0·91	0·33–0·99	23
Industrial workers working above shoulder height	M	Industrial workers working below shoulder height	69	17	11	2·7–42	0·91	0·63–0·98	16*
Assembly line packers	F	Shop assistants	9	4	2·6	0·91–7·4			17
Slaughterhouse workers	M	(Shop assistants)	3	4	0·70	0·16–3·0			17, 22
Scissors makers	F	Shop assistants	2	4	0·56	0·11–3·0			17, 18
Data entry operators	F	Office workers	1	2	0·54	0·03–8·8			21

*Case-referent study.
R1, R0, OR, 95 CI, EF, Ref No, see table 2.

meat carriers, dentists (two studies), miners, and heavy workers (table 2). The frequency of degeneration and osteoarthrosis was less among cotton workers than among the general population (table 3). The highest aetiological fraction for cervical spondylosis was 0·88 for meat carriers. Dentists, miners, and heavy workers had aetiological fractions of 0·75–0·81, 0·78, and 0·40, respectively (table 2).

CERVICAL SYNDROME

The reported point prevalence rates of cervical syndrome are low, ranging between 1 and 5 (table 4). A prevalence odds ratio of 4·8 was found for civil servants compared with iron foundry workers; the aetiological fraction was 0·79 (table 4).

THORACIC OUTLET SYNDROME (TOS)

The rates varied considerably, ranging from 44 for female assembly line workers (table 5) to 0·3 for industrial workers as described by Silverstein.[26] None of the studies showed a significant odds ratio. When the four groups were pooled a significant SOR of 4·0 was found; the aetiological fraction was 0·75 (table 3).

SHOULDER JOINT OSTEOARTHROSIS

Only one cross sectional study of dentists and farmers was found in which radiographs of the glenohumeral joint were taken in addition to radiographs of the cervical spine.[25] The prevalence rate per 100 of osteoarthrosis in the shoulder for dentists was 13 with an age SOR of 4·2 when contrasted with farmers. The

Table 7 *Tension neck syndrome. Prevalence rates (number of cases per 100 in group) and odds ratios for tension neck syndrome (shoulder muscle tenderness and pain). (Referents within parentheses not given by the original author of the study group)*

Occupational group	*Sex*	*Referents*	*R1*	*R0*	*OR*	*95 CI*	*EF*	*95 CI*	*Ref No*
Filmrolling workers	F	Teachers and nurses of handicapped children	100	65	118	6·9–1000	0·99	0·85–1	15
Female industrial workers	F	Male industrial workers	8	1	5·9	2·0–17	0·83	0·50–0·94	26
Lamp assemblers	F	Teachers and nurses of handicapped children	91	65	5·1	2·0–13	0·80	0·50–0·92	15
Data entry operators	F	Office workers	38	11	4·9	1·8–13	0·80	0·44–0·92	20
Typists	F	Office workers	35	11	4·2	1·6–11	0·76	0·38–0·91	20
Scissors makers	F	(Shop assistants)	61	28	4·1	2·3–7·2	0·76	0·57–0·86	17, 18
Conversational terminal operators	F	Office workers	28	11	3·2	1·2–8·2	0·69	0·17–0·88	20
Data entry operators	F	Office workers	47	28	2·3	1·1–4·6	0·57	0·09–0·78	21
Office workers	F	Teachers and nurses of handicapped children	80	65	2·1	0·92–4·8			15
Assembly line packers	F	Shop assistants	38	28	1·6	0·94–2·6			17
Slaughterhouse workers	M	(Shop assistants)	5	28	0·15	0·06–0·37			17, 22

*Case-referent study.
R1, R0, OR, 95 CI, EF, Ref No, see table 2.

95% confidence interval was 2·1–8·5 and the aetiological fraction 0·76 with confidence intervals of 0·53–0·88.

ROTATOR CUFF TENDINITIS

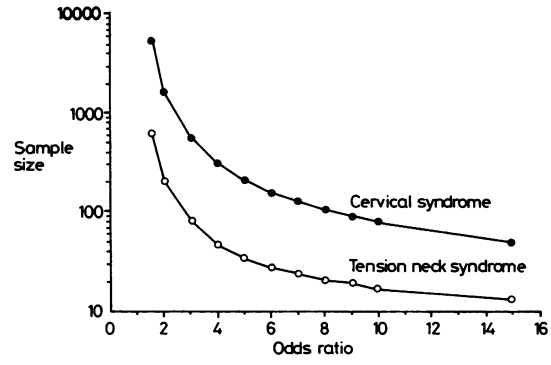
The reported prevalence rates among shipyard welders and plate workers are rather high, 18 and 16, respectively (table 6). The odds ratio for the two pooled studies of occupational groups with work tasks at shoulder level was 11 with an aetiological fraction of 0·91 (table 3).

TENSION NECK SYNDROME

Tension neck syndrome had the highest rates of all shoulder-neck diseases studied, reaching a point prevalence rate of 100 in Japanese filmrolling workers (table 7). Women tended to have higher rates of tension neck syndrome than men. The odds ratio for selected female industrial workers in the United States compared with male industrial workers was 5·9. Odds ratios significantly higher than 1·0 were found for data entry workers in two different studies, typists, assembly line packers, scissors makers, lamp assemblers, and in film rolling workers. In the pooled analysis of keyboard operators the SOR was 3·0 with an aetiological fraction of 0·67 (table 3).

Discussion

It is important to note that this evaluation of published data suffers from the incomplete or inadequate controlling for confounding factors such as sex or age in most studies. When performing a cross sectional study the aim is to investigate whether the group under study has an excess prevalence of a disorder that could be related to the characteristic of the occupational exposure of the group. The power has also to be considered when evaluating these studies. The non-significant exposure effect relations reported for thoracic outlet syndrome and cervical disc disease may be due to low power—that is, the prevalence rates of the diseases are low and thus the sample sizes needed to detect a risk must be large (figure). For tension neck syndrome which is more common the sample size needed for risk assessment is considerably less (figure). If the disorder disables the worker the prevalence rate of the disorder will be affected by a healthy worker effect. The low prevalence and prevalence odds ratios of cervical syndrome (cervical disc disease) may possibly be inaccurate owing to a healthy worker effect, since an episode of cervical syndrome may disable a worker or force a transfer from



Sample size for both study and referent group needed to detect with 90% probability the odds ratios between 1·5 and 15 ($p < 0·05$) for cervical syndrome assumed to have rate (prevalence) 2 per 100 in general population and tension neck syndrome assumed to have rate (prevalence) of 25 per 100 in general population.[35]

a job with high load on the cervical spine. By contrast, when the shoulder-neck disease causes little or no disability, high prevalence rates may occur. The reported high prevalence of tension neck syndrome may partly be due to the fact that this disorder causes little or late disability.

In the epidemiological analysis we urge that the raw data are presented stratified by age and exposure. Furthermore, the odds ratios and their confidence intervals should also be presented. Computation of the aetiological fraction is helpful for the evaluation of the impact of exposure. If the time of onset of symptoms is assessed in a cross sectional study it is then possible to compute the incidence densities. By comparing the incidence densities for different years in both the study and the referent groups it is possible to estimate the magnitude of the healthy worker effect as suggested by Punett and Robins.[36] The exposure in the reports we examined was most often given by job title or industry. A detailed description regarding working postures, arm and head movements, material handled, and work organisation would have made comparisons between studies easier. A job title such as "office worker" describes a potentially large variety of occupational tasks. Office workers may be supervisors without repetitive movements or constrained work postures but may also be data entry operators. It was not possible in the present study to examine the effect of exposure from physical load but only the exposure attributable to job title. In most of the examined reports the hypothesis of exposure-effect relation was that a certain job title was at risk for a disorder, the exposure as load on the shoulder and neck was usually not quantified in any way. This makes it hard to conclude what the exposure characteristics are that separate the study group from the referent group. We suggest that the exposure of the study and the referent groups should be given, preferably in parametric quantitative measures. For local load evaluation information is necessary on working postures, arm and head movements, weight, shape and frequency of object handled, and work organisation (how long are the work periods between rests and pauses, for example). Some standardised techniques have been described for job analysis, most are time consuming, however. There is a great need for a standardised simple way to assess physical exposure. The effect measures examined in this paper were diseases (where we have information about them) which were better described than exposures but not well understood in terms of precursors of disability or indicators of decreased quality of life. The use of cervical spondylosis as a measure of effect may be questioned since the correlation between radiographic spondylosis and symptoms is poor.[37 38] We recommend that the criteria for the effect (disease) be presented in detail in future. Identification of shoulder-neck diseases may not be optimal when the objective is to get early warnings of exposures that may cause disability and pain. Other effect measures could include standardised function tests (measures of muscle strength and endurance), serological tests (creatine kinase), or recording of changes of the activities of daily life (hobbies, sport).

Judging from recent studies, the prevalence of reported complaints consistent with a disorder is higher when the symptoms alone are compared with symptoms plus physical examination. The prevalence rate of tension neck syndrome among male industrial workers in the United States was reported to be 4·9% from interview data alone. When cases confirmed by a positive physical examination were counted, the rate dropped to 1·4%.[26] Even though there is little misclassification of the shoulder-neck diseases when physical examination is performed, those diseases may not be the appropriate outcome measure.

CERVICAL SPONDYLOSIS

The hypothesis of the exposure causing cervical spondylosis is that of a high load on the cervical spine. There were occupational groups with a significant odds ratio above 1·0, meat carriers, dentists, miners, and heavy workers. The meat carriers carried their meat partially on their heads, placing a high load on the cervical spine,[8] which is consistent with findings of an increased rate of cervical spondylosis in a Jamaican rural population who carried burdens on their heads.[39] An increased load on the cervical spine in miners could possibly occur for miners due to the effect of helmet or extreme positions of the cervical spine or both. Sources for a high load on the cervical spine, however, have not been described for dentists and heavy workers. Frequent extreme positions of the cervical spine may possibly occur for dentists, giving a high load on the cervical spine. The finding of less cervical spondylosis among cotton workers compared with the general population is obscure. This cannot simply be explained by a healthy worker effect since symptoms due to cervical spondylosis are rare. Furthermore, the possibility that other occupations with high load on the cervical spine (miners, for example) in the general population could be the cause of this healthy worker effect is not likely since the female cotton workers showed the same tendencies for less spondylosis compared with the general population.

CERVICAL SYNDROME

The exposure hypothesised to give cervical syndrome (or signs and symptoms consistent with cervical syndrome) is extreme forward flexion of the cervical spine.[40 41] If the civil servants had work posture with flexed cervical spine this could cause symptoms con-

forming to the cervical syndrome. Another plausible explanation for the significant odds ratio above one, however, would be that cervical syndrome would be more disabling for an iron foundry worker compared with a civil servant. Thus the finding of raised odds ratio in clerical workers may represent a healthy worker effect operating for iron foundry workers compared with civil servants.

THORACIC OUTLET SYNDROME (TOS)

Rates for TOS varied considerably from 0·3 to 44; this may reflect not only difference in the true rates but also in diagnostic criteria. Individually, none of the studies showed a significant exposure-effect relation. Under the hypothesis that short cycle repetitive arm work gives a static load on the neck and shoulder girdle muscles that may promote a thoracic outlet syndrome (perhaps only in individuals with constitutional factors such as musculoskeletal abnormalities) the pooled analysis showed a significant odds ratio of an exposure-effect relation.

GLENOHUMERAL JOINT OSTEOARTHROSIS

Mechanical stresses may be one aetiological factor in osteoarthrosis.[42] Nevertheless, glenohumeral joint load among dentists has not been documented as an explanation for the significant odds ratio of shoulder joint osteoarthrosis. It should be noted that osteoarthrosis of the glenohumeral joint is rare before the sixth decade in the general population[43] and that the correlation between radiographic signs and symptoms is poor.[44 45]

ROTATOR CUFF TENDINITIS

Impingement of the rotator cuff tendons under the coracoacromial arch have been suggested as the main cause of rotator cuff tendinitis.[46] The exposure giving impingement is a work task demanding raising of the arms. The three occupational groups studied with work likely to be at or above shoulder level had a significantly high odds ratio and aetiological fraction for rotator cuff tendinitis.

TENSION NECK SYNDROME

The hypothesised exposure causing tension neck syndrome is static tension (contraction) of the neck and shoulder-neck muscles.[5 47] The pooled analysis showed a high odds ratio for the "keyboard operators." This may reflect the exposure of a static load on the upper trapezius muscle measured by EMG.[48]

This examination of reports of prevalence of shoulder and neck disorders has clearly shown that certain job titles are associated with shoulder-neck disorders. Furthermore, for some of the disorders, both the rates and the aetiological fractions in the exposed groups are high, implying that occupational preventive measures could be effective. Although job analysis was not done for most of the studies, the basis for grouping studies points toward specific exposure factors such as highly repetitive contractions in the shoulder muscles, work at or above shoulder level, static contractions, and possibly head posture as causative factors in shoulder-neck disorders.

We thank Professor Hal Morgenstern, School of Public Health, Division of Epidemiology, UCLA, for supplying us with a Fortran program for analysis of cross sectional studies and for valuable comments on this manuscript.

This study was supported by grants from the Swedish Work Environment Fund.

References

1 Hadler NM. Industrial rheumatology, clinical investigation into influence on pattern of use of regional musculoskeletal disease. *Arthritis Rheum* 1977;**20**:1019–25.
2 Cunningham LS, Kelsey JL. Epidemiology of musculoskeletal impairments and associated disability. *Am J Public Health* 1984;**74**:574–9.
3 Maeda K, Horiguchi S, Hosokawa M. History of the studies on occupational cervicobrachial disorders in Japan and remaining problems. *J Hum Ergol* 1982;**11**:17–29.
4 Westgaard RH, Aarås A. Postural muscle strain as a causal factor in the development of musculo-skeletal illnesses. *Applied Ergonomics* 1984;**15**:162–74.
5 Waris P. Occupational cervicobrachial syndromes. *Scand J Work Environ Health* 1979;**6** suppl 3:3–13.
6 Kellgren JH, Lawrence JS. Rheumatism in miners. *Br J Ind Med* 1952;**9**:197–207.
7 Hult L. Cervical, dorsal and lumbar spinal syndromes. *Acta Orthop Scand* 1954: suppl 17.
8 Schroter G. Hat die berufliche Belastung Bedeutung für die Entsthung oder Verschlimmerung der Osteochondrose und Spondylose der Halswirbelsaule. *Deutsche Gesundheitswesen* 1959;**14**:174–7.
9 Lawrence JS. Rheumatic in cotton operatives. *Br J Ind Med* 1961;**18**:270–6.
10 Newell DJ. Prevalence, aetiology and treatment of pain in the neck and arm. *Transactions of the Society of Occupational Medicine* 1967;**17**:104–6.
11 Partridge REH, Andersson JAD, McCarthy MA, Duthie JRR. Rheumatic complaints among workers in iron foundries. *Ann Rheum Dis* 1968;**27**:441–3.
12 Partridge REH, Duthie JJR. Rheumatism in dockers and civil servants: a comparison of heavy manual and sedentary workers. *Ann Rheum Dis* 1968;**27**:559–67.
13 Schroter G. Zur frage der Überbelastungsschaden der Halswirbelsaule bei Stenotypistinnen. *Z Gesamte Hyg* 1968;**14**:333–7.
14 Schroter G, Rademacher W. Die Bedeutung von Belastung und aussergewhonlicher Haltung für das Entstehen von Verschleiss-schaden der HWS—dargestellt an einem Kollektive von Fleischabträgern. *Z Gesamte Hyg* 1971;**17**:841–3.
15 Onishi N, Nomura H, Sakai K, Yamamoto T, Hirayama K, Itani T. Shoulder muscle tenderness and physical features of female industrial workers. *J Hum Ergol* 1976;**5**:87–102.
16 Bjelle A, Hagberg M, Michaelson G. Clinical and ergonomic factors in prolonged shoulder pain among industrial workers. *Scand J Work Environ Health* 1979;**5**:205–10.
17 Luopajarvi T, Kuorinka I, Virolainen M, Holmberg M. Prevalence of tenosynovitis and other injuries of the upper extremities in repetitive work. *Scand J Work Environ Health*

1979;6 suppl 3:48–55.
18 Kuorinka I, Koskinen P. Occupational rheumatic diseases and upper limb strain in manual jobs in a light mechanical industry. *Scand J Work Environ Health* 1979;6 suppl 3:39–47.
19 Herberts P, Kadefors R, Andersson G. Shoulder pain in industry: an epidemiological study of welders. *Acta Orthop Scand* 1981;52:299–306.
20 Hunting W, Laubli T, Grandjean E. Postural and visual loads at VDP workplaces. *Ergonomics* 1981;24:917–31.
21 Kukkonen R, Luopajarvi T, Riihimaki V. Prevention of fatigue amongst data entry operators. In: Kvalseth TO, ed. *Ergonomics of workstation design*. London: Butterworths, 1983:28–34.
22 Viikari-Juntura E. Neck and upper limb disorders among slaughterhouse workers. *Scand J Work Environ Health* 1983;9: 283–90.
23 Herberts P, Kadefors R, Högfors C, Sigholm G. Shoulder pain and heavy manual labor. *Clin Orthop* 1984;191:168–78.
24 Sällström J, Schmidt H. Cervicobrachial disorders in certain occupations with special reference to compression in the thoracic outlet. *Am J Ind Med* 1984;6:45–52.
25 Katevuo K, Aitasalo K, Lehtinen R, Pietila J. Skeletal changes in dentists and farmers in Finland. *Community Dent Oral Epidemiol* 1985;13:23–5.
26 Silverstein BA. *The prevalence of upper extremity cumulative trauma disorders in industry*. Ann Arbor: University of Michigan, Occupational health and Safety Engineering, 1985. (Thesis.)
27 Kleinbaum DG, Kupper LL, Morgenstern H. *Epidemiologic research*. Belmont: Lifetime Learning Publications, 1982.
28 Miettinen OS. Standardization of risk ratios. *Am J Epidemiol* 1972;96:383–8.
29 Greenland S. Interpretation and estimation of summary ratios under heterogeneity. *Statistics in Medicine* 1982;1:217–27.
30 Woolf B. *Statistical methods for rates and proportions*. 2nd ed. New York: Wiley, 1955:160–5.
31 Greenland S. Interpretation and estimation of summary ratios under heterogeneity. *Statistics in Medicine* 1982;1:217–27.
32 Andersson JAD, Duthie JJR, Moody BP. Social and economic effects of rheumatic diseases in a mining population. *Ann Rheum Dis* 1962;21:342–51.
33 Waris P, Kuorinka I, Kurpa K, *et al*. Epidemiologic screening of occupational neck and upper limb disorders. *Scand J Work Environ Health* 1979;6 suppl 3:25–38.
34 Roos DB. Congenital anomalies associated with thoracic outlet syndrome. *Am J Surg* 1976;132:771–8.
35 Schlesselman JJ. *Case-control studies*. New York: Oxford University Press, 1982.
36 Punnett L, Robins JM, Adjusting for selection bias in cross-sectional studies: soft tissue disorders in garment workers. In: Punnett L, ed. *Soft tissue disorders of the upper limb*. Boston: Harvard School of Public Health, 1985:119–46. (Thesis.)
37 Friedenberg ZB, Miller WT. Degenerative disc disease of the cervical spine. *J Bone Joint Surg* 1963;45A:1171–8.
38 Lawrence JS. Disc degeneration: its frequency and relation to symptoms. *Ann Rheum Dis* 1969;28:121–38.
39 Bremner JM, Lawrence JS, Mial WE. Degenerative joint disease in a Jamaican rural population. *Ann Rheum Dis* 1968;27: 326–32.
40 Frykholm R, Hyde J, Norlen G, Skoglund CR. On pain sensation produced by ventral stimulation of ventral roots. *Acta Physiol Scand* 1953;29, suppl 106.
41 Harms-Ringdahl K. *On assessment of shoulder exercise and load-elicited pain in the cervical spine*. Stockholm: Karolinska Institute, 1986. (Thesis.)
42 Radin EL. Mechanical aspects of osteoarthrosis. *Bull Rheum Dis* 1976;26:862–5.
43 Peterson CJ. Degeneration of the glenohumeral joint. *Acta Orthop Scand* 1983;54:277–83.
44 De palma AF. *Surgery of the shoulder*. Philadelphia: Lippincott, 1950.
45 Olsson O. Degenerative changes of the shoulder joint and their connection with shoulder pain. *Acta Chir Scand* 1953, suppl 181.
46 Neer CS. Impingement lesions. *Clin Orthop* 1983;173:70–6.
47 Hagberg M. Occupational musculoskeletal stress and disorders of the neck and shoulder: a review of possible pathophysiology. *Int Arch Occup Environ Health* 1984;53:269–78.
48 Hagberg M, Sundelin G. Discomfort and load on the upper trapezius muscle when operating a wordprocessor. *Ergonomics* 1986;29:1637–45.

Destruction of manuscripts

From 1 July 1985 articles submitted for publication will not be returned. Authors whose papers are rejected will be advised of the decision and the manuscripts will be kept under security for three months to deal with any inquiries and then destroyed.