

Self-reported symptoms in the neck and upper limbs of female assembly workers

Impact of length of employment, work pace, and selection

by Kerstina Ohlsson, BScPT, Robyn Attewell, MSc, Staffan Skerfving, MD¹

OHLSSON K, ATTEWELL R, SKERFVING S. Self-reported symptoms in the neck and upper limbs of female assembly workers: impact of length of employment, work pace, and selection. *Scand J Work Environ Health* 1989;15:75—80. In a questionnaire study 148 women in assembly work reported statistically significantly higher rates of pain, in the last 7 d, in their shoulders (odds ratio 3.4) and hands (odds ratio 2.8) as compared to 60 referents age-adjusted. There was a strong association between duration of employment and complaints in the hands. For the younger women, but not the older ones, there was an increase in pain in the shoulders, neck, and upper back with duration of employment. The odds ratio for pain in the shoulders and neck increased with an increasing work pace, except for very high paces, for which there was a decrease. Among 76 former assembly workers 26 % reported pain as the cause of having left this work. There was no overall increase in the frequency of complaints among those who had left.

Key terms: elbow, hand, healthy worker effect, rate, repetitive work, shoulder, upper back.

Pain in the musculoskeletal system is a major problem in occupational settings. Such pain is often the cause of long periods of sick leave. One study has shown that no less than about half of sick leaves are due to musculoskeletal disorders (1). It has been stated that, among these disorders, pain in the neck and the shoulders often causes disability with respect to work among industrial and office employees (2). Knowledge of the determinants of the risk of these disorders is incomplete.

In industry, certain tasks are particularly associated with musculoskeletal problems, among them, some types of assembly work (3). Assembly work is often characterized by work with the arms elevated forward and outward and repetitive movements, which may cause muscular pain and tendinitis (1, 4—6). Furthermore, workers doing repetitive work are often paid by a piece-rate system that often results in a fast work pace. In turn a fast work pace may increase the risk of developing symptoms (7), though the degree of its impact is not known. Neither is the effect of its duration clear. Although there is an association between increasing age and chronic complaints of the musculoskeletal system (8, 9), it has not been established whether the association is due to aging of the tissues or to the increasing exposure time that is usually associated with age.

The true size of the problem in a particular occupational setting is often uncertain due to the fact that people with pain might leave their work, and cross-

sectional studies thus may display an underestimate of risk ("healthy worker selection").

In the present study, we have studied the interaction between duration and rate of assembly work and age on one hand and neck-shoulder-arm pain on the other. In addition we have investigated any healthy worker selection.

Subjects and methods

Study groups

One group was formed from 148 workers currently employed in a factory producing and assembling plastic components, eg, for electrical equipment and for the automobile industry. The work of these subjects was characterized by repetitive arm and hand movements in constrained work postures. Their mean age at the start of employment was 29 (range 16—61) years, their mean employment time 65 (range 1—265) months, and their mean age at the time of the study 35 (range 18—65) years.

A second group consisted of all the female workers (N = 76) who had left assembly work in the aforementioned factory during the four years preceding the study. The mean employment time of this group was 67 (range 1—195) months, and its mean age at the start of employment was 31 (range 16—55) years.

Reference group

Sixty women were randomly sampled from the general population in a nearby area. These women had different kinds of jobs, eg, in health care, banking, and housework. The mean age of this group was 37 (range 23—59) years.

¹ Department of Occupational Medicine, University Hospital, Lund, Sweden.

Reprint requests to: Ms K Ohlsson, Department of Occupational Medicine, University Hospital, S-221 85 Lund, Sweden.

Work tasks and complaints

A questionnaire was used (10) to gather data on the women's work tasks and musculoskeletal complaints. The women answered the questionnaire individually, gathered in groups of four or five persons. Personnel from the Department of Occupational Medicine and from the Company Health Service were present. The questionnaire included issues concerning musculoskeletal pain from the neck, upper back, and upper extremities (during the last 7 d and during the last 12 months), as well as pain which had affected work ability (during the last 12 months). The women were also asked about work tasks and some factors regarding the organization of their work. Information on their work pace was obtained from a question concerning the number of items the women completed per hour.

Statistical methods

Logistic regression was used to model the relationships between pain in a specific location and a number of factors which may jointly affect the likelihood of reporting pain. The odds ratios produced by such models can be interpreted as estimates of incidence proportion or as the incidence density ratio. The suitability of such models for cross-sectional studies has been discussed earlier (3, 11, 12). Our study satisfies the assumptions required since we have a so-called extended risk period in so far as "noncases" were still at risk to develop symptoms at the end of the study and we had no reason to believe that the duration of symptoms was not significantly different for the assembly and reference workers.

The factors we studied included age, whether or not the woman worked at the factory, duration of employment, and work pace. Age and employment duration were, in general, treated as continuous variables, whereas work pace (available for 126 subjects only) was divided into four classes (slow: <100 items/h, medium: 100–199 items/h, fast: 200–700 items/h, and very fast: >700 items/h). For the 60 reference subjects, employment duration was set at zero. In some cases more complicated models involving age as an effect modifier (or interaction term) were required. For such cases, age was treated as a continuous variable,

but for illustrative purposes the material was also divided into two age groups by dichotomization at the mean age of 35 years. The mean age among the "younger" women was 26 years, and that of the "older" ones was 44 years.

The significance of the main effects and interactions between two factors was assessed in a comparison of the difference in deviance (a numeric summary of goodness of fit) with the chi-square distribution.

The results of the modeling were in general displayed graphically by plotting of the predicted odds against the effect of main interest (ie, length of employment), with division into subgroups if there was a significant interaction term. For a crude visual appraisal of the fit, observed odds were also plotted for the models involving length of employment. The subjects were then divided according to employment time into six groups roughly equal in size, and the odds for each group were calculated (the number with pain divided by the number without).

The odds ratio (OR) for persons characterized by a single factor or a set of factors is defined as the odds for pain given the presence of these factors, divided by the odds for some arbitrarily defined reference group. Consequently, this group has its odds ratio set at unity (1.0). The choice of reference depended on the factors in the model. For example, for the model involving the effect of work pace on the risk for pain, the reference group was the slowest workers.

Results

The total group of current workers had, in comparison with the reference group, numerically higher frequencies of pain in all the regions studied (table 1) when pain during the last 7 d and pain during the last 12 months and work inability were considered. With regard to pain during the last 7 d, the difference was statistically significant for the shoulders (OR 3.4) and hands (OR 2.8) (with age adjustment).

In the following text, we present the results for pain during the last 7 d only.

Table 1. Percentage of 148 women occupied with assembly work (A) and 60 referents (R) with pain in the upper back, the neck, and the upper extremities. The odds ratios (A vs R), adjusted for age, and the 95 % confidence intervals are given.

Region of the body	In the last 12 months								Pain in the last 7 d			
	Pain				Work inability							
	Assembly workers (%)	Referents (%)	Odds ratio	95 % confidence interval	Assembly workers (%)	Referents (%)	Odds ratio	95 % confidence interval	Assembly workers (%)	Referents (%)	Odds ratio	95 % confidence interval
Upper back	33	28	1.5	0.7–2.9	8	8	1.2	0.4–3.7	22	15	2.1	0.9–4.9
Neck	39	32	1.9	0.9–3.7	13	7	2.8	0.9–8.8	21	17	1.6	0.7–3.6
Shoulders	55	45	2.0	1.1–4.0	21	10	2.4	1.0–5.8	38	18	3.4	1.6–7.1
Elbows	21	17	1.5	0.6–3.4	10	3	2.8	0.8–10.7	14	11	1.9	0.7–5.3
Hands	43	32	1.8	0.9–3.5	18	7	2.6	0.7–9.6	28	15	2.8	1.2–6.4

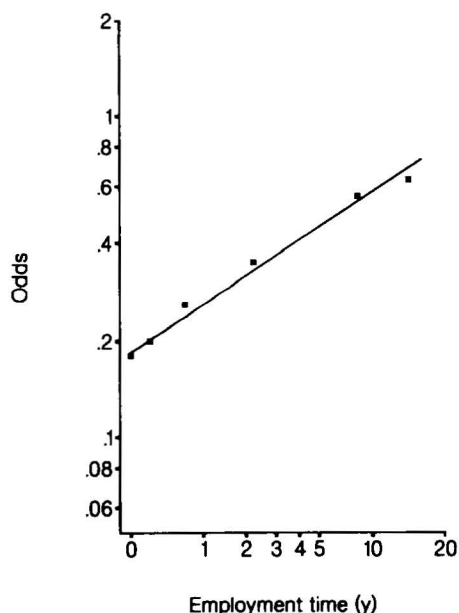


Figure 1. Association between duration of employment and pain in the hands during the last 7 d (adjusted for age) in 148 women in assembly work and in 60 referents (employment time = 0). A line representing the predicted odds calculated from the model at age 35 years is shown, as well as the observed odds calculated for the referents and the assembly workers grouped in five employment-time classes. (y = years)

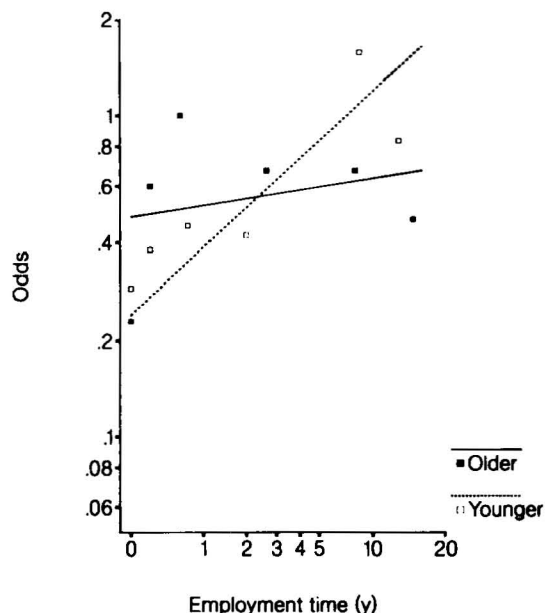


Figure 2. Association between duration of employment and pain in the shoulders during the last 7 d in 148 women in assembly work and in 60 referents (employment time = 0). The data have been dichotomized by the mean age (35 years) into "younger" (open symbols, broken line) and "older" (closed symbols, unbroken line) women. The lines have been calculated, according to a model (including age), at the mean age within these two age groups. Also shown are the observed odds for the two groups, for the referents and the assembly workers grouped in five employment-time classes. (y = years)

The odds for pain in the hands increased as length of employment increased ($P = 0.002$) with age adjustment. The estimated odds ratio after 15 years of work in the present factory was approximately four (figure 1).

As for pain in the shoulders there was also a statistically significant increase in the odds with duration of employment ($P = 0.03$). Further modeling, however, revealed a statistically significant interaction between age and duration of employment ($P = 0.01$). In other words, the degree of increase in the odds with the duration of employment depended on age. It was steepest for the young, and the slope decreased (became less steep) with age. This result is illustrated in figure 2 with the material divided into groups younger and older than the mean age, as described in the methods section. For the younger subjects, the odds increased significantly as the duration of employment increased ($P = 0.01$), while for the older ones there was no statistically significant change with length of employment. The older women who had been employed for shorter periods of time had more complaints than the younger ones. For those with longer employment times, the relationship was the opposite.

The pattern was the same for pain in the neck (figure 3) and in the upper back (figure 4). There was no association between length of employment and complaints concerning elbows.

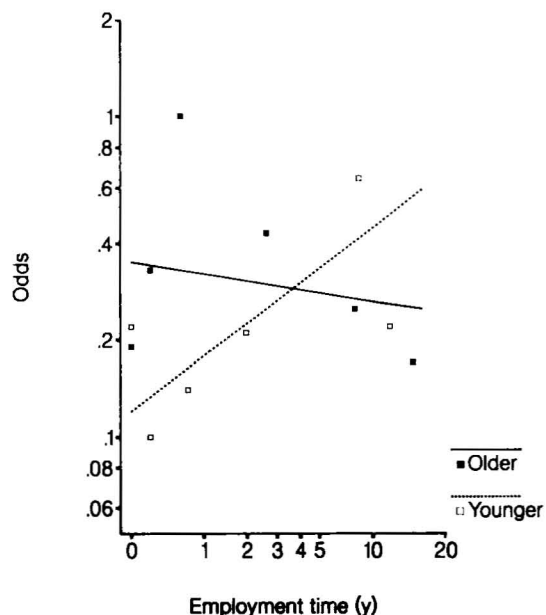


Figure 3. Association between duration of employment and pain in the neck during the last 7 d in 148 women in assembly work and in 60 referents (employment time = 0). The data have been dichotomized by the mean age (35 years) into "younger" (open symbols, broken line) and "older" (closed symbols, unbroken line) women (as in figure 2). (y = years)

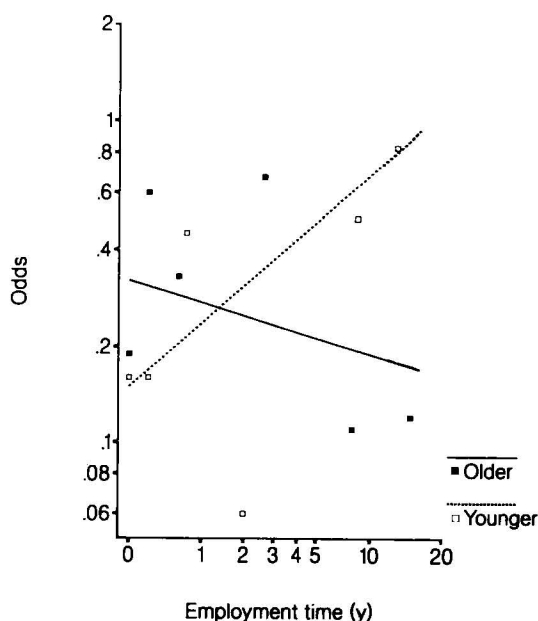


Figure 4. Association between duration of employment and pain in the upper back during the last 7 d in 148 women in assembly work and in 60 referents (employment time = 0). The data have been dichotomized by the mean age (35 years) into "younger" (open symbols, broken line) and "older" (closed symbols, unbroken line) women (as in figure 2). (y = years)

Table 2. Percentage of 148 women active in assembly work and 76 former workers with pain in the upper back, the neck, and the upper extremities during employment.

Region of the body	Active assembly workers	Former assembly workers
Upper back	34	31
Neck	35	41
Shoulders	53	55
Elbows	22	15
Hands	44	45

Table 3. Reasons for leaving employment for 76 former female assembly workers.

Reason for leaving	Age (years)					
	< 35		≥ 35		All	
	N	%	N	%	N	%
Pain in the musculoskeletal system	9	20	11	35	20	26
Other diseases	1	2	2	6	3	4
Unhappy with work environment	8	18	3	10	11	14
Family reasons	27	60	15	48	42	55
Total	45	100	31	100	76	100

The odds for pain in the shoulders varied with the work pace for the 126 persons with work pace estimates ($P = 0.0001$) (figure 5) with simultaneous adjustment for age and length of employment. It was higher for the medium and fast groups than for the slow one ($P = 0.0006$, for both), but lower for the persons in the

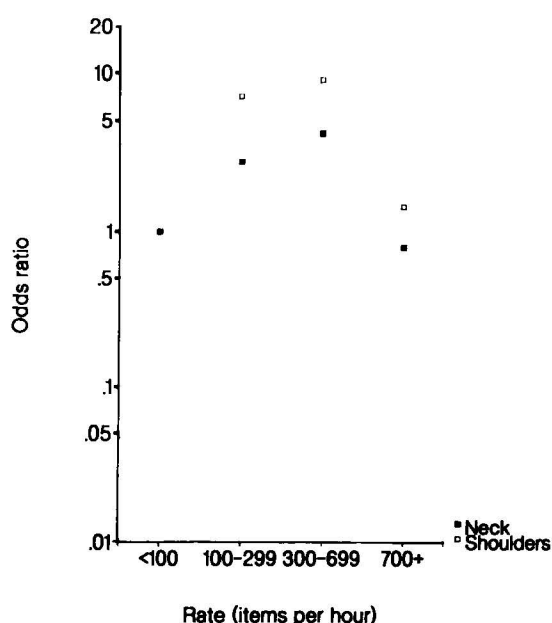


Figure 5. Associations between work pace (rate) and both pain in the shoulders (open symbols) and neck (closed symbols) in 126 women in assembly work. The odds ratios are shown (relative to the slowest group), predicted from models adjusting for age and employment time.

very fast group than for those in the medium- and fast-paced groups.

The pattern of the odds for pain in the neck was similar (figure 5), but not statistically significant ($P = 0.07$), being higher for the medium ($P = 0.1$) and fast ($P = 0.04$) groups than for the slow one. Again, the risk was lower for the very fast group than for the medium- and fast-paced groups.

Concerning the odds for pain in the hands, elbows and upper back, there were no statistically significant associations with work pace (not illustrated).

When comparing frequencies of pain between current and former workers, we found no statistically significant overall differences (table 2).

Not less than 55 % of those who had left work in the factory claimed reasons other than pain, ill health, or a poor work environment as the cause of ending employment (table 3). Prevalent claims were retirement, child birth, housework, and change of work for other reasons. However, 26 % had left because of pain.

There was a tendency ($P = 0.08$) for younger women to have left because of "family reasons" (mean age 36 years), and older women for health reasons (mean age 42 years). Thus we fitted a model allowing the odds ratio for pain between the former and the current workers to vary depending on age (while still adjusting for employment duration). There were no statistically significant effects for any region. However, when only women employed for more than five years were considered, we did observe an interaction with age. The

odds ratio for former versus current workers increased with age and exceeded unity at the age of approximately 45 years for pain in the neck ($P=0.04$) (figure 6), upper back ($P=0.03$) (not illustrated), and shoulders ($P=0.07$) (not illustrated), but no such relationship was observed for the elbows and hands. Thus, among the older workers, those that left after at least five years had a higher frequency of pain in the neck, upper back, and shoulders.

Discussion

The questionnaire approach to studying musculoskeletal disorders is rather crude. Thus we cannot be sure of the objective disorder prevalence and intensity of pain. However, there was no reason to believe that there was systematic difference of reporting pain between the exposed and the reference groups or a bias dependent upon age, length of work, or work pace. However, among the former employees, there may have been an underestimate of complaints, as they may have forgotten their true experience during work.

In addition, the work pace was not assessed objectively, but instead with the use of a questionnaire. However, as the subjects were paid per item, their answers were probably accurate.

Because of a supposed better accuracy, a better discrimination between exposed and reference subjects and a better estimate of the point prevalence, we chose to use reported symptoms in the last 7 d rather than those reported in the last 12 months in the more detailed analyses.

The results of this study clearly showed that women in assembly work have a very high prevalence of musculoskeletal pain, particularly in the shoulders and hands. As we only had limited information on any potential occupational exposure to this kind of work among the referents, the true incidence ratio might be even higher, although probably not very different from the observed odds ratio, as the prevalence of industrial work among the referents was low. The present risk for pain is similar, and for some regions of the body even higher, than reported earlier in groups with comparable exposures (3, 6, 13). This kind of work imposes an unacceptable risk of occupational disease.

The relationship with the work environment was further strongly supported by the fact that there was a marked association with duration of exposure. In the case of the hands, this association was straightforward. However, with the shoulders, neck, and upper back, the pattern was more complex. We found a dose-response relationship for "younger" women, but not for "older" ones. There are at least three different possible explanations of this age discrepancy. First, the work-associated complaints may be diluted by a high frequency of pain from other causes in the older women. On the other hand, there was no difference in the prevalence of pain in younger and older referents. Sec-

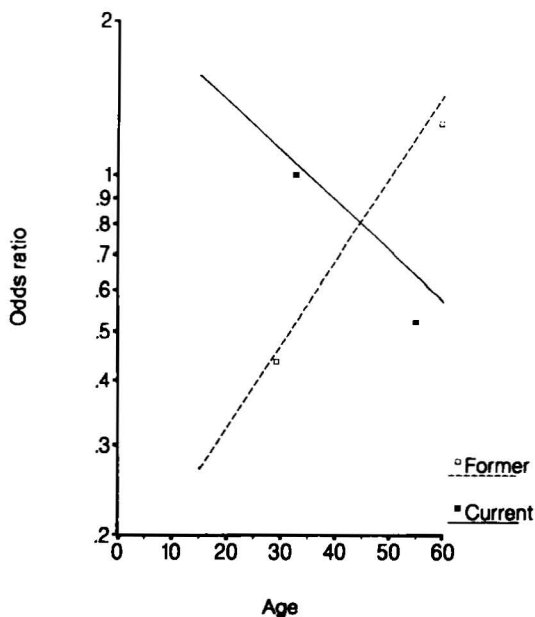


Figure 6. Association between age (in years) and pain in the neck, during employment, in 60 current (closed symbols, unbroken line) and 47 former (open symbols, broken line) assembly workers, all of whom had worked for at least five years. The lines represent the predicted odds ratio (relative to current workers aged 35 years) for the two groups. Also shown are the crude odds ratios for former and current workers aged less than 45 years and those aged 45 years or more.

ond, young women may endure constrained work well during the first years of employment and thus only gradually develop complaints, while older women may rapidly suffer pain when exposed to this work. This possibility is supported by the shape of the dose-response curves. Third, there might have been a selective quitting of subjects with complaints, only the healthiest being left in the assembly work. In the dose-response curves, such an effect seems to appear for long times of exposure. The presence of healthy worker selection is also supported by the study of former workers.

Furthermore, there was an association between pain and work pace which is in accordance with some earlier data (7, 14). But the pattern was not simple. The frequency of pain increased for the shoulders and neck from the low to the medium pace. However, surprisingly, at high speed, there was a decrease. This phenomenon may again be due to selection; subjects with pain may not sustain this strain. In addition, the work tasks and/or the ergonomic arrangements might differ between low/medium and very rapid work situations.

There is a widespread assumption that subjects with complaints are more apt to leave work than those without and, if so, an underestimate of risk occurs in cross-sectional studies. Our results showed that the pattern was more complicated. Thus there was not a statistically significant higher frequency of complaints among the total group of those who had quit. However, pain

is only one reason for women leaving work. Other reasons, mainly family ones, are more important among young women.

Indeed, there was a "healthy worker selection," but only among older women with longer lengths of employment. This is probably the reason for the aforementioned fact that there was no increase in the occurrence of pain in the shoulders, neck, and upper back with a longer duration of work for the older women. With hands and elbows, no selection was recorded, probably due to the different character of the complaints. For subjects with such symptoms, it is possible to survive by making adjustments in the work. In addition, such pain does not often last for as long a period as that in shoulders or in the neck or upper back.

One reason why we did not note any selection among the younger women may be that they, despite the pain, manage to keep on working. The possibility of receiving a disability pension is also greater for older women.

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