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Prevalence of shoulder and upper-limb disorders among workers in the fish-processing industry

by Horn-Che Chiang, MD,¹ Yin-Ching Ko, MD,² Shun-Shen Chen, MD,³ Hsin-Su Yu, MD,⁴ Trong-Neng Wu, PhD,⁵ Po-Ya Chang, MD,⁵

CHIANG H-C, KO Y-C, CHEN S-S, YU H-S, WU T-N, CHANG P-Y. Prevalence of shoulder and upper-limb disorders among workers in the fish-processing industry. *Scand J Work Environ Health* 1993;19:126-31. A cross-sectional study was conducted among fish-processing workers to evaluate the prevalence of shoulder and upper-limb discomforts and to assess the associated ergonomic risk factors. A prestructured interview, a medical check-up, and job analyses were performed to determine musculoskeletal disorders among 207 workers in eight factories. The results showed shoulder girdle pain (30.9%), epicondylitis (14.5%), and carpal tunnel syndrome (15.0%) as the three most common soft-tissue disorders. The odds ratio of shoulder girdle pain was 1.6 (95% CI 1.1-2.5) among the workers who performed tasks with repetitive movement of their upper limbs, while it was 1.8 (95% CI 1.2-2.5) for the workers who sustained forceful movement of their upper limbs during work. Women taking oral contraceptives had a 2.0 times higher odds ratio for carpal tunnel syndrome than did other women. It would appear that untrained or unskilled workers were prone to suffer from musculoskeletal disorders.

Key terms: carpal tunnel syndrome, epicondylitis, ergonomics, oral contraceptive, shoulder girdle pain.

Work-related musculoskeletal disorders are nowadays a major problem in intensive manual work. Much has been published on shoulder pain, neck tension syndrome, epicondylitis, tenosynovitis, and carpal tunnel syndrome, but the etiology of these soft-tissue disorders is still not understood very well (1-2). There are many different diagnostic terms in use that complicate any etiologic study intended to compare the occurrence of these disorders among occupational groups subjected to various work loads (3-5). A good study design and reliable observations are needed to elucidate such relationships.

In one study the main cause of sick leave among female hospital workers was musculoskeletal disorders, which affected 16% of the women (6), while, according to the Finnish Register of Occupational Diseases, soft-tissue disorders occur at the highest rate in the food industry (7). The prevalence of epi-

condylitis and tenosynovitis has been reported to be 8.9 and 4.5%, respectively, among meatcutters (8). The lifetime prevalence of shoulder girdle pain has been shown to be as high as 23% in a group of manual workers (3). In one study (9) the annual incidence of tenosynovitis or peritendinitis was 25.3% among female packers, 16.8% among female sausage makers, and 12.5% among male meatcutters. While the annual incidence of epicondylitis was about 1% for workers in nonstrenuous jobs, it was 11.3% for female sausage makers, 7.0% for female packers, and 6.4% for male meatcutters.

The work load on the wrist and hands in the fish processing industry is different from that in meat processing plants. Frozen fish, the raw material, is usually lighter and slipperier than meat, and the work process has been mechanized on nearly every work-site. The heavy physical exertion of the whole body has changed to light loads on the upper extremities and shoulders. But cutting and sorting are still carried out manually. Thus intermittent shoulder pain, neck tightness, and aching upper limbs are frequent complaints in the industry.

The purpose of our study was to determine the prevalence of upper-limb musculoskeletal disorders among fish processing workers and to evaluate the relationship between ergonomic risk factors and shoulder or upper-limb disorders.

Subjects and methods

Study population

This was a cross-sectional study, whose base was a population cross-section of a cohort of workers in the

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eight fish-processing factories in and around Kaohsiung harbor in Taiwan. The factories were small to medium size, as most factories are in Taiwan. All of the workers who entered the fish processing industry before June 1990 and were employed there full-time were part of the cohort. However, those who suffered from hypertension, diabetes mellitus, a history of traumatic injuries to the upper limbs, arthritis, and collagen diseases were excluded. A total of 232 employees agreed to participate in the study, of whom 207 met the study criteria and were included. The cross-sectional examination consisted of a standardized questionnaire and clinical screening carried out by an experienced occupational physician. To prevent observer bias, we examined the workers in a random sequence known only by the factory managers. At the time of the medical examination, the jobs of the examinees were analyzed by a member of our department and the local industrial hygienist.

The workers in our study were classified into three groups according to the ergonomic risks to their shoulders and upper limbs in their occupation rather than according to their job titles. But, for a better understanding of these groups, the job titles were recorded. The 61 workers (32 men and 29 women) in group I, low repetitiveness and low forceful movement of the upper limbs, were composed of managers, office staff, and skilled craftsmen. Group II, the 118 workers (29 men and 89 women) with jobs involving high repetitiveness or highly forceful movement of the upper limbs, were semiskilled persons working at conveyor belts in processing fish into classic Chinese dishes, the small-sized fish dumpling, and packers of the product. The 28 workers (6 men and 22 women) in group III, whose tasks comprised high repetitiveness and highly forceful movement of the upper limbs, cut, separated, or sorted the fish or other sea food. The mean ages of the workers were 36.7 (SD 10.3), 34.6 (SD 11.5), and 36.5 (SD 13.6) years for groups I, II, and III, respectively.

Job analyses

The regular daily tasks and components of the workers' limb movements while performing the tasks were determined for three workers, each representing one of the three groups under study. We observed and recorded the biomechanic movements of each worker for at least 30 min or three work cycles. The term "high-least" repetitive or forceful movements in the present study has been defined previously by Silverstein et al (10). The highly repetitive jobs were those with a cycle time of less than 30 s or more than 50% of the cycle time involved in performing the same type of fundamental cycles. The hand-force requirements of the jobs were estimated by bilateral surface electromyographic recordings from the forearm flexor muscles. The high force jobs were those with an estimated average hand force of more than 3 kg.

Clinical diagnoses of shoulder and upper-limb disorders

In this study we employed the term "shoulder girdle pain," as defined by Anderson (3), to represent the cervical brachial syndrome, neck and upper-limb disorder, and neck-shoulder problems. Hence a wide range of diagnoses associated with pain in the neck, shoulder, or upper arms in addition to signs of at least two tender points or palpable hardenings, or both, which may be either caused or aggravated by work conditions, were the diagnostic criteria of shoulder girdle pain.

The criteria for the diagnosis of epicondylitis were adopted from Roto & Kivi (8). Local tenderness, pain during resisted extension or flexion of the wrist and fingers and decreased hand grip compared with that of the opposite hand were essential signs for epicondylitis.

The diagnosis of carpal tunnel syndrome was primarily adopted from Baker & Ehrenberg (11). The general criteria used to screen for carpal tunnel syndrome were as follows: (i) symptoms of numbness, pain, or tingling in the fingers innervated by the median nerve, (ii) positive Tinel's sign or Phalen's test, (iii) onset of carpal tunnel syndrome since work in current job began, and (iv) no evidence of carpal tunnel syndrome in relation to systemic diseases or injuries. All of these criteria had to be met for a positive diagnosis.

Statistical analyses

The SAS PC (statistical analysis system for the personal computer) software package was used for the statistic analyses throughout the study. To test the hypothesis that frequencies of symptoms or disorders among workers in the three groups (group I: repetitive = 0 and forceful movement = 0; group II: either repetitive = 0 and forceful movement = 1 or repetitive = 1 and forceful movement = 0; group III: repetitive = 1 and forceful movement = 1) were increased with the severity of ergonomic risk factors, the Mantel-Haenszel chi-square test for trend was employed for the trend analyses. The odds ratio (OR) statistic was used to determine the odds in favor of disorder when specific predictors were present. The predictors studied were age (continuous variable), gender (0 = male, 1 = female), repetitiveness (0 = least, 1 = high), forceful movement of the upper limbs (0 = least, 1 = high), and the interaction of repetitiveness and forceful movement of the upper limbs (Rep $\times$ Force). The OR and 95% confidence interval (95% CI) were calculated with the CATMOD procedure of the SAS multiple logistic regression analyses.

Results

Of the 207 employees in the eight plants, 64 (30.9%) were clinically diagnosed as having shoulder girdle

Table 1. Occurrence (%) of shoulder girdle pain, carpal tunnel syndrome, and epicondylitis among 207 fish-processing workers by plant.

Plant	Number of subjects	Shoulder girdle pain	Epi-condylitis	Carpal tunnel syndrome
A	41	29.3	12.2	12.2
B	20	30.0	15.0	10.0
C	22	31.8	13.6	13.6
D	58	34.5	13.8	15.5
E	24	37.5	8.3	12.5
F	15	26.7	20.0	20.0
G	9	33.3	33.3	22.2
H	18	27.8	22.2	16.7
Total	207	30.9	14.5	15.0

Table 2. Occurrence (%) of self-reported symptoms and physician-observed disorders in the shoulders and upper limbs of 207 fish-processing workers (during the last 30 d) by group. (Group I = the least repetitive and least sustained forceful movement of the upper limbs; Group II = highly repetitive or highly sustained forceful movement of the upper limbs; and Group III = highly repetitive and highly sustained forceful movement of the upper limbs)

	Group I (N = 61)	Group II (N = 118)	Group III (N = 28)	Chi-square value ^a	P-value ^a
Symptoms by body parts					
Shoulder	14.8	44.1	50.0	12.2	0.000
Neck	6.6	13.6	21.4	4.09	0.043
Elbow	18.0	19.5	35.7	2.57	0.109
Wrist	8.2	17.8	25.0	4.68	0.031
Hand	13.1	21.2	32.1	4.35	0.037
Physician-observed disorders					
Shoulder girdle pain	9.8	37.3	50.0	18.4	0.000
Epicondylitis	9.8	15.3	17.9	2.19	0.140
Carpal tunnel syndrome	8.2	15.3	28.6	5.89	0.015

^a The chi-square and P-values indicate the Mantel-Haenszel chi-square test for trend analysis and its probability, respectively.

Table 3. Occurrence (%) of shoulder girdle pain, epicondylitis, and carpal tunnel syndrome among the 207 fish-processing workers by gender and group. (Group I = the least repetitive and least sustained forceful movement of the upper limbs; Group II = highly repetitive or highly sustained forceful movement of the upper limbs; and Group III = highly repetitive and highly sustained forceful movement of the upper limbs)

Physician-observed disorders	Group I (N = 61)	Group II (N = 118)	Group III (N = 28)	Chi-square value ^a	P-value ^a
Shoulder girdle pain					
Men	9.4	31.0	50.0	6.88	0.009
Women	10.3	39.3	50.0	9.41	0.002
Total	9.8	37.3	50.0	18.4	0.000
Epicondylitis					
Men	6.3	10.3	33.3	2.78	0.095
Women	13.8	16.9	18.2	0.19	0.664
Total	9.8	15.3	21.4	2.19	0.139
Carpal tunnel syndrome					
Men	3.1	6.9	0.0	0.02	0.881
Women	13.8	18.0	36.4	3.57	0.059
Total	8.2	15.3	28.6	5.89	0.015

^a The chi-square and P-values indicate the Mantel-Haenszel chi-square test for trend analysis and its probability, respectively.

pain, 31 (15.0%) as afflicted with epicondylitis, and 30 (14.5%) as suffering from carpal tunnel syndrome (table 1). Regardless of the small to middle size of the eight plants, the occurrences of the aforementioned musculoskeletal disorders did not show significant differences between the plants. The prevalence and percentage distribution of the self-reported history of musculoskeletal symptoms during the last 30 d before the survey and the physician observed, clinically screened disorders are presented in table 2. When the subjects from each plant were pooled, the most prominent subjective complaint was shoulder discomfort (36.2%, 75 of 207 workers). Other complaints were elbow (21.3%, 44 of 207 workers), hand (20.3%, 42 of 207 workers), wrist (15.9%, 33 of 207 workers), and neck (12.6%, 26 of 207 workers) discomfort. The workers in group III usually complained more frequently of shoulder (50.0%), neck (21.4%), wrist (25.0%), and hand symptoms (32.1%) than the other workers did.

Except for elbow symptoms, a significant increasing trend was observed in the ratio of subjective symptoms in the shoulders and upper limbs from group I to group III. The prevalence of the physician-observed shoulder girdle pain, epicondylitis, and carpal tunnel syndrome in the clinical screening was 30.9% (64 of 207 workers), 14.5% (30 of 207 workers), and 15.0% (31 of 207 workers), respectively. There were also significant increasing trends in the ratios of cases of shoulder girdle pain and carpal tunnel syndrome as ergonomic risk factors increased in severity from group I to group III (table 2). When cases of the shoulder and upper-limb disorders were analyzed by gender, we still detected a significant increasing trend for the occurrence of shoulder girdle pain among both genders, but not for carpal tunnel syndrome and epicondylitis (table 3). However, if analyzed by duration of employment (short-term exposure < 12 months, moderate exposure 12–60 months, and long-term exposure > 60 months), workers with short-term exposure showed a significant increasing trend in the ratio of shoulder girdle pain, carpal tunnel syndrome, and epicondylitis (table 4), whereas workers with long-term exposure did not.

Shoulder girdle pain and carpal tunnel syndrome were two of the three common soft-tissue disorders for which the ratio of cases in the three study groups displayed statistically significant trends (table 3). Therefore a multiple logistic regression analysis of the relationship between disorders and ergonomic risk factors was carried out. The results showed that repetitiveness (OR 1.6, 95% CI 1.1–2.5) and forceful movements (OR 1.8, 95% CI 1.2–2.5) were the two major predictors of shoulder girdle pain, whereas age or gender were not significant confounding factors (table 5). In contrast, gender was found to be a significant predictor (OR 2.6, 95% CI 1.3–5.2) of carpal tunnel syndrome (table 6), and it indicated that women were more likely to suffer from the syn-

Table 4. Occurrence (%) of shoulder girdle pain, epicondylitis, and carpal tunnel syndrome among the 207 fish-processing workers by duration of employment and group. (Group I = the least repetitive and least sustained forceful movement of the upper limbs; Group II = highly repetitive or highly sustained forceful movement of the upper limbs; and Group III = highly repetitive and highly sustained forceful movement of the upper limbs)

Physician-observed disorders	Group I (N = 61)	Group II (N = 118)	Group III (N = 28)	Chi-square value ^a	P-value ^a
Shoulder girdle pain					
< 12 months	0.0	40.0	33.3	4.19	0.041
12–60 months	9.7	38.8	69.2	15.9	0.000
> 60 months	18.8	25.0	33.3	0.52	0.470
Epicondylitis					
< 12 months	0.0	8.6	33.3	5.81	0.016
12–60 months	6.5	19.4	23.1	2.73	0.099
> 60 months	25.0	12.5	0.0	2.22	0.137
Carpal tunnel syndrome					
< 12 months	7.1	20.0	44.4	4.32	0.038
12–60 months	9.7	11.9	0.3	0.29	0.592
> 60 months	6.3	18.8	33.3	2.52	0.113

^a The chi-square and P-values indicate the Mantel-Haenszel chi-square test for trend analysis and its probability, respectively.

drome. Forceful movements (OR 1.8, 95% CI 1.1–2.9) but not repetitiveness of the upper limbs was also a significant predictor of carpal tunnel syndrome. In our study, interaction between repetitiveness and forceful movement was not found to be a predictor of shoulder girdle pain or carpal tunnel syndrome. Further analysis of the female workers' risk factors showed the consumption of oral contraceptives to be a predictor of carpal tunnel syndrome, oral pill users being at a 2.0 times greater risk than other women (95% CI 1.2–5.4) (table 7). Forceful wrist movement (OR 1.6, 95% CI 1.1–3.0) was a potential risk predictor for the female workers, but the repetitiveness of upper-limb movement was not.

Discussion

In hand-intensive manual work certain tasks are particularly associated with pain in the musculoskeletal system. Studies have revealed that different jobs show either higher or lower levels of disorder prevalences. Viikari-Juntura (5) reported a high occurrence of pain or reported symptoms in the neck and shoulder (49.1%) and arms and hands (59.8%) of slaughterhouse workers. Another study (12) reported that neck pain (39%), shoulder pain (55%), pain in elbows (21%), and pain in hands (43%) were the major musculoskeletal problems among female assembly workers. According to the data reported by Viikari-Juntura (5), the occurrence of tension neck syndrome among slaughterhouse workers was 6.2%, but it was 61.3% among scissor makers, 27.8% among shop assistants, and 37.5% among factory workers doing repetitive tasks. The occurrence of tenosynovitis and peritendinitis of the wrist and forearm was also diverse, being 4.4% among slaughter-

Table 5. Predicted association between some factors and shoulder girdle pain in the logistic regression analyses. (95% CI = 95% confidence interval, Rep = repetitive movement of the upper limb, Force = sustained forceful movement of the upper limb, Rep × Force = interaction of Rep and Force)

Predictors	Standard error	Odds ratio	95% CI
Intercept	0.496	3.0	1.1–7.8
Age	0.013	1.0	0.9–1.1
Gender	0.220	1.1	0.7–1.7
Rep	0.211	1.6	1.1–2.5
Force	0.189	1.8	1.2–2.5
Rep × Force	0.187	1.4	1.0–2.0

Table 6. Predicted association between some factors and carpal tunnel syndrome in the logistic regression analyses. (95% CI = 95% confidence interval, Rep = repetitive movement of the upper limb, Force = sustained forceful movement of the upper limb, Rep × Force = interaction of Rep and Force)

Predictors	Standard error	Odds ratio	95% CI
Intercept	0.73	33.4	7.9–141
Age	0.02	1.0	0.9–1.1
Gender	0.35	2.6	1.3–5.2
Rep	0.25	1.1	0.7–1.8
Force	0.24	1.8	1.1–2.9
Rep × Force	0.24	1.1	0.7–1.8

Table 7. Predicted association between some factors and carpal tunnel syndrome in the logistic analyses for the female workers. (95% CI = 95% confidence interval, Rep = repetitive movement of the upper limb, Force = sustained forceful movement of the upper limb)

Predictors	Standard error	Odds ratio	95% CI
Intercept	1.02	21.2	2.9–156
Age	0.02	0.9	0.9–1.0
Contraception			
Oral pill	0.39	2.0	1.2–5.4
Tubal ligation	0.61	0.6	0.2–2.0
Other	0.48	1.1	0.4–2.8
Rep	0.33	1.5	0.8–2.8
Force	0.28	1.6	1.1–3.0

house workers, 18.3% among scissor makers, 13.5% among shop assistants, but 55.9% among factory workers doing repetitive tasks. The results our study showed that the major subjective complaints among fish-processing workers were shoulder pain (36.2%), neck pain (12.6%), pain in the elbows (21.3%), and pain in the hands (20.3%). The clinically diagnosed disorders were shoulder girdle pain (30.9%), epicondylitis (15.0%), and carpal tunnel syndrome (14.5%). No significant plant effect was found in this study although the size of the eight plants was inconsistent and the main tasks of the jobs differed somewhat. We found that, no matter what the job titles were, symptoms of the neck, shoulder, and upper limbs were the common problems for the workers in this industry with hand-intensive work. How-

ever, because of the different tasks, different definitions of clinical terms, and different study design, the results of our study are difficult to compare with those of the other aforementioned studies.

Relatively high prevalences of subjective symptoms and disorders were found in our study. Laxly applied clinical criteria may be an important contributor. According to the criteria used for shoulder girdle pain, painful conditions can arise locally in the neck and suprascapular and upper dorsal regions, or was referred from a nerve root or other spinal source. Hence our results concerning clinically diagnosed shoulder girdle pain could have been biased if the workers suffered from backache or other associated conditions. For the clinical diagnosis of epicondylitis, bias could have resulted from different palpation pressures used by the examiner and from differences in the threshold of tenderness to the pressure. But for purposes of preventing work-related musculoskeletal injuries, it would be more appropriate to use lax criteria in epidemiologic surveys so that disorders can be screened in their early stages.

To increase the reliability of self-reporting, during the interview, we asked all of the workers to indicate the location of the painful region on a schematic drawing of the human body. Therefore, the discrepancy between self-reported symptoms and physician-observed abnormalities was reduced (table 2). To avoid recall bias, we asked about symptoms that occurred in the last 30 d rather than those that had occurred in the last 12 months, as previously reported.

High repetitiveness and highly forceful movements were two important ergonomic factors associated with musculoskeletal disorders of the hand and upper arm. Irrespective of other factors, the combination of these two increased the magnitude of association substantially more than either factor alone (10). Accordingly, we tested the data in tables 2, 3, and 4 with the Mantel-Haenszel chi-square test for trend analyses. The ratios of subjective symptoms in different body parts increased from group I to group III. Shoulder girdle pain and carpal tunnel syndrome also showed a similar, statistically significant increasing trend. To prevent the confounding effect of gender, we stratified the cases of shoulder and upper-limb disorders by gender (table 3). The relationship between frequencies of disorders and levels of ergonomic risk factors among the three groups was confirmed.

Shoulder and upper-limb disorders were not found to be significantly associated with duration of employment. But we observed a significant dose-response relationship between the magnitude of risk factors and the occurrence of shoulder and upper-limb disorders among workers with short-term exposure (table 4). Because most of these people were semiskilled, they were likely to leave their job if they felt frequent muscle pain because of it. Thus we believe the selection mechanism may explain a part of

the lack of significant associations between these soft-tissue disorders and the duration of employment. Probably another manifestation of this mechanism was the finding that age was shown to be a negative predictor of shoulder girdle pain and carpal tunnel syndrome (tables 5–7). In addition the workers with long-term exposure were trained and physically fit individuals who could maintain an efficient posture or action and perform their tasks well with an adequate recovery phase with less strain (13).

Most of the workers processing the raw fish or semimanufactured products had to match the speed of a conveyer belt. Their task was not dissimilar to those of electronic assembly workers. The execution of a repetitive task without an adequate recovery phase results in static and dynamic loading of the neck, shoulder, and upper-limb musculature. A sustained isometric contraction may be required of these muscles to support and fix the arm in a functional position. A dynamic loading or repetitive movement is required of the forearm, wrist, hand, and fingers to execute a task (13). Our findings agree. Sustained forceful movement and repetitiveness were the two statistically significant predictors of shoulder girdle pain in the logistic regression analysis. The odds ratio of shoulder girdle pain was 1.6 (95% CI 1.1–2.5) for the fish processing workers who performed tasks with repetitive movements of the upper limbs and 1.8 (95% CI 1.2–2.5) for the workers who sustained forceful movement of the upper limbs during work.

The clinical epicondylitis observed in our study was composed of lateral and medial epicondylitis in the dominant work hand. Although epicondylitis of the lateral and medial side was mixed as a category, there was slightly more lateral epicondylitis than medial epicondylitis. We chose relatively lax diagnostic criteria for the early detection of suspected cases and for increasing the sensitivity for further epidemiologic analyses. Our study, as well as previous studies (1, 8), did not find a connection between epicondylitis and repetitive or strenuous manual work. We believe that workers with epicondylitis are more disabled in their work than those with forearm or shoulder problems. Thus sick leave may be an important reason for the controversial result. Both previous studies and our study have shown only a small amount of evidence of the ergonomic role of hand-intensive work in the occurrence of epicondylitis.

As for carpal tunnel syndrome, previous studies have indicated that middle-aged women who perform their daily task with repetitiveness and sustained forceful movements of the wrist are prone to suffer from work-related carpal tunnel syndrome (14–16). In our study, 4.5% of the male workers and 20.0% of the female workers were diagnosed as having clinical carpal tunnel syndrome. The crude relative risk of carpal tunnel syndrome for the female workers was 4.4 times higher than for the male workers. The logistic regression model showed that, after adjust-

ment for age, the odds ratio of the female workers was still 2.6 times higher than that of the male workers' (table 6). Because gender was an important predictor (male = 0, female = 1, OR 2.6, 95% CI 1.3–5.2), it was further analyzed. In table 7 the odds ratio for the women on contraceptive pills (OR 2.0, 95% CI 1.2–5.4) showed a weak statistical association with carpal tunnel syndrome. Use of oral contraceptives and other drugs, including weakly androgenic compounds, has been associated with carpal tunnel syndrome (17–18). But another study found that a history of gynecologic surgery, specifically hysterectomy with bilateral ovariectomy, was strongly associated with the carpal tunnel syndrome among workers (19). Further epidemiologic and biochemical research on women with carpal tunnel syndrome is needed to explain the influence of hormonal changes on the onset of carpal tunnel syndrome in women.

Repetitiveness, as defined in this study from our job analysis, may differ somewhat from the repetitiveness related to carpal tunnel syndrome (ie, that involving the whole upper-limb movement, not merely the wrists). This difference may well explain why repetitiveness was not shown to be a statistically significant predictor of carpal tunnel syndrome in our study. But there was still a significant increasing trend for the prevalence of carpal tunnel syndrome as the degree of ergonomic factors increased from group I to group III.

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