HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT
HETA 84-187-L1966
STANDARD PUBLISHING COMPANY
CINCINNATI, OHIO
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Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations and Field Studies
National Institute for Occupational Safety and Health
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NIOSH INVESTIGATORS:
Paul Seligman, M.D.
Daniel Habes, M.S.E
Michael Crandall, C.I.H.
REPORT PREPARED BY:
Anne T. Fidler, Sc.D.

BACKGROUND

On February 15, 1984, NIOSH received a request from the management of the Standard Publishing Company, Cincinnati, Ohio to evaluate cases of carpal tunnel syndrome (CTS) and ganglionic cysts among employees working as machine helpers in the bindery area. The management request was made at the recommendation of Mr. William M. Murphy, Director of the Occupational Safety and Health Administration (OSHA) Cincinnati Area Office. OSHA's concern was based on their observation during an inspection of the plant on December 15, 1983 through January 4, 1984, of a high incidence of CTS and ganglionic cysts.

NIOSH investigators made an initial visit on March 26, 1984, and a letter summarizing the walk-through visit was forwarded to the company on April 10, 1984. Videotapes were recorded during the March 26th visit, and a letter detailing recommendations to reduce the observed ergonomic hazards was forwarded to management and OSHA on July 18, 1984.

Standard Publishing employed approximately 450 people in the manufacturing and marketing of a variety of lithographic products. Of the total employee population, 75 individuals worked in the bindery area. The plant operated 6 days per week over three shifts. Approximately 60% of the production area workforce was female. Among the bindery employees, 81% were white and 15% were black. A previous hazard evaluation (HE 80-74-714) conducted at Standard Publishing found that complaints of eye and throat irritation from employees working in the platemaking area were probably due to perchloroethylene decomposition products.

The bookbinding operations require considerable manual material handling. In pocket feeding areas where signatures are unloaded and fed into machines, each stack of signatures requires varying degrees of bending and jogging in order to maintain quality control and production standards. In addition to the potential ergonomic hazards posed by material handling, a wide variety of lifting operations are performed in moving materials from pallets to machines. Other than the physical agents, a wide variety of water-based lacquers, adhesives, and degreasing agents are used in the printing and binding operations. Exposures to these chemicals were not addressed in this hazard evaluation.

MEDICAL/ERGONOMIC EVALUATION

On August 8, 1984, 54 (72%) of 75 full-time employees in the bindery area completed a self-administered questionnaire designed to determine the frequency of wrist and forearm symptoms occurring in the preceding month, and

of the diagnosis of certain wrist conditions. The purpose of the survey, in addition to estimating the prevalence of wrist and arm problems among bindery workers, was to select for further evaluation persons with and without evidence of carpal tunnel syndrome (CTS), a repetitive trauma disorder which affects the median nerve of the arm and hand. All of the results of the initial evaluation will not be reported here, as they have been reported to the company previously (letter dated February 4, 1985). However, of note is the relatively high percentage of persons reporting wrist and forearm symptoms (Table 1).

On May 7, 1985, 18 employees identified in the preliminary survey participated in a medical and ergonomic evaluation. Of this number, four individuals were considered potential cases of carpal tunnel syndrome (CTS), based on a history of feelings of numbness, tingling, and pins and needles sensations in one or both hands which caused the individual to be awakened while sleeping. Fourteen individuals were selected as controls on the basis of no previous symptoms involving either upper extremity. The medical examination consisted of a detailed self-administered questionnaire, measurements of height, weight, and grip strength, a determination of vibratory sensation thresholds using the index finger of both hands, and a physical examination by a rheumatologist from the University of Cincinnati. Employees were informed of the results of their physical examination at the time of the examination. Finally, videotapes of the 18 employees were obtained for ergonomic analysis.

Of the four individuals identified as potential cases of CTS, only one was considered to have CTS, based on a more restrictive definition, i.e., a "case" based on both initial and follow-up questionnaires and physical examination findings. Because there was only one case of probable CTS identified, no further analyses were warranted.

REVIEW OF OSHA 200 LOGS

Review of the OSHA 200 Logs for the years 1978 through March 1984 revealed 17 conditions associated with cumulative or repeated trauma among bindery workers (Table 2). Although no cases of carpal tunnel syndrome were identified on the OSHA Logs, two individuals currently employed were noted to have had surgery for CTS in the past. Two other persons interviewed were currently experiencing symptoms consistent with a diagnosis of CTS. The estimated incidence rate of disorders associated with repeated trauma at Standard Publishing for the 6 1/4-year period under study is 362.7 per 20,000,000 person-hours (ph) worked. This number is derived by dividing the numerator of 17 disorders by the denominator, calculated as 75 employees multiplied by 6.25 years under study, multiplied by 2000 ph per year. The incidence rate of disorders associated with repeated trauma among workers in Standard Industrial Classification (SIC) 2730, from the BLS Annual Report, is 8.5/20,000,000 ph. (BLS rates are presented as disorders per 20,000,000 ph, which represents 10,000 employees working 40 hours per week, 50 weeks per year.) The incidence rate experienced at Standard Publishing is therefore 42.7 times higher than the rate at other plants performing similar work.

Despite this markedly high rate of cumulative trauma disorders at Standard Publishing, it should be noted that OSHA Log information has been shown to underreport acute and chronic musculoskeletal injury, in part due to individual differences in interpretation of the meaning of a "recordable event" and to differences in the inclination of examining physicians to label injuries as "work-related." Several studies that compared OSHA 200 Log records of cumulative trauma disorders and plant medical records demonstrated a significant underreporting on OSHA Logs.[1-3] Though this issue was not addressed specifically at this plant, the possibility that cumulative traumas may go unreported in OSHA Logs should be considered, particularly in light of the identification of individuals who reported having had surgery for CTS and yet were not listed on the OSHA 200 Logs.

The higher number of cumulative trauma disorders (CTDs) found in the OSHA logs than in the survey conducted in August 1984, can be explained by several factors. These include the fact that the OSHA logs included a variety of disorders, not limited to the very strict definition of carpal tunnel syndrome (CTS) used in the survey. In addition, the disorders identified by OSHA logs included all cases that were reported over a 6 1/4-year period, whereas the NIOSH survey identified only individuals who were experiencing symptoms of CTS over a much shorter period of time (April to August 1984).

In order to provide assistance in reducing the high rate of disorders associated with cumulative trauma disorders observed among bindery workers at Standard Publishing, the following discussion of CTDs is presented, followed by recommendations to reduce the ergonomic stresses observed among bindery workers.

CUMULATIVE TRAUMA DISORDERS

Cumulative trauma disorders (CTDs) of the musculoskeletal system often occur in workers with jobs that require repetitive upper extremity exertion. These disorders can present themselves as bursitis, ganglionic cysts, musculoskeletal strain, synovitis, tendinitis, tenosynovitis, and/or numerous other specifically described musculoskeletal syndromes, including carpal tunnel syndrome. Studies have shown that these disorders can be precipitated and aggravated by activities associated with repetitive exertion, particularly if completion of the tasks requires significant application of force in an awkward posture.[4-17] The postures most often associated with upper extremity CTDs are wrist extension and flexion, ulnar and radial deviation of the wrist, open-hand pinching, twisting movements of the wrist and elbow, and shoulder abduction. CTDs are considered in many cases to be work-related because these types of postures and movements are required in many manufacturing and assembly jobs in industry. Occupations for which a high incidence of CTDs are known to exist include electronic components assembly, textile manufacture, small appliance manufacturing and assembling, meat processing and packing, fish filleting, buffing, and filing. The incidence of CTDs in these and other industries has not yet been established, but incidences as high as 44 cases per 100 workers per year have been reported.[18] Non-occupational risk factors for CTDs include hobbies and

recreational activities, such as woodworking, tennis, weight lifting, knitting, and sewing. All of these pastimes impose physical demands on the musculotendinous system similar to those of the jobs mentioned above.

Carpal tunnel syndrome was recognized as a clinical entity as early as 1895. However, not until 1947 was this median nerve problem fully described and recognized as a syndrome in medical literature. Symptoms of CTS include pain and parasthesias (burning and tingling sensation) in the hand along the distribution of the affected median nerve, precipitation of similar symptoms at night while sleeping, and possible radiation of pain to other portions of the involved arm/hand.[19-23] Carpal tunnel syndrome may be associated with non-occupational factors such as acute trauma, diabetes mellitus, hormonal factors (use of oral contraceptives, pregnancy, gynecological surgery), rheumatoid arthritis, acromegaly, wrist shape/size, congenital (birth) defects, and gout.[24] Since a number of these conditions are unique to, or more common among women, their risk of carpal tunnel syndrome may be elevated. While women have been reported to be at high risk for CTS due to occupational factors, very few studies have compared the rate of CTS in men and women performing identical jobs. Silverstein, et al. found that women and men had essentially the same risk if performing identical job activities.[25,26]

There are several factors which may precipitate occupational cumulative trauma injury. Among these are excessive muscular force, short length of job cycles, and high frequency of movements. One study found that workers performing jobs with force levels of 4 kilograms or more were four times as likely to develop a hand/wrist CTD than those workers whose jobs required muscular exertions of 1 kilogram or less.[27] Job tasks with cycle times lasting 30 seconds or less were found to be associated with an incidence of upper extremity CTDs three times greater than those jobs where the cycle time was greater than 30 seconds.[27] In studies reporting an increased incidence of CTDs, where the number of hand movements were recorded, the range was from 5000 to 50,000 repetitions per day.[28-34] The work activities were varied and included cutting poultry, keystroking, hand sanding/filing, and packing tea.

Because of the complexity of repetitive motion patterns, it has been difficult to define a critical frequency factor for defining a CTD risk. Therefore, the current strategy for reducing the risk of CTDs for a certain task is to minimize exposure to job factors that are biomechanically stressful, that is, involve high force, awkward postures, or high repetition rates. Reduction in risk for precipitation of CTDs and other musculoskeletal injuries is most effectively achieved through the redesign of work stations, tools, and/or reassessment of work methods.

RECOMMENDATIONS

After review of videotapes made of workers performing a wide variety of job tasks, a number of observations and recommendations are made to reduce postural stress. These recommendations were provided previously to the management of Standard Publishing in a letter dated July 18, 1984.

1. Install load leveling pellet systems at the packing lines to eliminate the bending required to place finished printed material into shipping bins. Such systems are also recommended in the pocket feeding areas where signatures are unloaded and fed into machines.

2. For standing operators, particularly those feeding pockets, provide mats to stand on to minimize foot and leg fatigue.

3. For handwork helpers carrying bundles of paper, provide a removable handle to eliminate the need to carry the loads by a thin wire.

4. For each type of signature, determine the necessary amount of bending and jogging that is required to maintain quality control standards and instruct workers as to the proper procedure. This measure is recommended because the amount of signature preparation varied greatly among workers, including those working with similar materials. Some workers were observed bending and folding completed booklets before packing, which should not be necessary at all.

5. Avoid using binder boards that are smaller than the signature being bound. This practice bends the signature, greatly increasing the amount of handling needed to flatten it enough to be fed into the pockets.

6. Provide adjustable footstools for those working at heights where the wrists are above the elbows. This applies to some of the signature feeders, but primarily to box folding and stapling jobs. Fixtures that assist in the assembly of boxes could also be considered.

7. In the paper cutting areas, consider providing thickness-sensitive calipers which can be used to measure out quantities of paper to be cut. This would eliminate the need to count sheets of paper by hand.

8. In the hand gathering area, install an automatic box taping or stapling device to eliminate the need to smooth out tape manually.

9. In the same area, encourage packers to squeeze excess air out of the shrink-wrapped packages using a neutral wrist position with the hand in a fist. This would eliminate the forceful wrist extension posture observed. Some type of percussion tool with a handle is also a possible alternative in this job.

10. In all areas, limit stacks of palletized boxes to no more than shoulder height to eliminate excessive shoulder abduction and extension.

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Table 1

Standard Publishing Company
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Frequency of Symptoms Among Bindery Workers
Survey, August 1984

SYMPTOM	# WITH SYMPTOM/ # RESPONDING	PERCENT
Hand numbness	10/54	18.5%
Arm soreness	16/52	30.8%
Awakening at night with pain or numbness in hand	11/51	21.6%
Discomfort that interferes with routine activities	10/52	19.2%
Previous diagnosis of carpal tunnel syndrome	5/46	10.9%
Previous diagnosis of ganglionic cysts	4/43	9.3%
Previous diagnosis of tendinitis of wrist	4/43	9.3%

Table 2

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Cumulative Trauma Disorders Identified Through
Review of OSHA 200 Logs, January 1978 - March 1984

PROBLEM	NUMBER	JOB TITLES
Wrist Strain/Sprain	8	Handwork Helper (7); Machine Operator (1)
Wrist Pain	3	Handwork Helper (2); Machine Operator (1)
Hand/Wrist Swelling	3	Handwork Helper (1); Machine Helper (2)
Thumb Pain	1	Machine Helper
Torn Wrist Tendon	1	Handwork Helper
Ganglionic Cyst	1	Handwork Helper
TOTAL	17	