

A Study on Upper Extremity Cumulative Trauma Disorder in Different Unorganised Sectors of West Bengal, India

Somnath GANGOPADHYAY, Arpita RAY, Avijit DAS, Tamal DAS, Goutam GHOSHAL, Prasun BANERJEE and Sonchita BAGCHI

Department of Physiology, Ergonomics Laboratory, University College of Science and Technology, University of Calcutta, India

Abstract: A Study on Upper Extremity Cumulative Trauma Disorder in Different Unorganised Sectors of West Bengal, India: Somnath GANGOPADHYAY, *et al.* Department of Physiology, Ergonomics Laboratory, University College of Science and Technology, University of Calcutta, India—Cumulative trauma disorder (CTD) is a term used to describe a class of soft tissue injuries that result due to a number of occupational activities. These disorders commonly occur among workers who are engaged in highly repetitive jobs involving continuous hand exertion, vibration and localized mechanical pressure. In the present investigation, an attempt was made to evaluate the prevalence of CTD among workers associated with strenuous hand intensive jobs in unorganized sectors in India and to highlight the unsafe working conditions to which these workers have been exposed for several years. For this purpose, an experiment was performed on 25 male workers from each group. The groups were classified into meat cutters, typists, tailors, visual display terminal (VDT) operators & weavers. For the symptom survey, a questionnaire and checklist method was implemented. Along with these, a detailed time study was performed among the workers during different activities in the total work cycle. For this study a two-tail chi-square test of independence was applied to determine whether or not the feeling of discomfort had any significant association with the repetitiveness of the work. From the observations and analysis of the results, it was revealed that all the activities are repetitive, i.e. over 50% of the work cycle of each activity involved the respective main activity where similar kinds of motion patterns were performed. Therefore it can be concluded that high repetitiveness, prolonged work activity and remaining in static posture

for a prolong period of time may be regarded as the causative factors in the occurrence of CTD. (*J Occup Health 2003; 45: 351–357*)

Key words: India, CTD, Meat cutters, Typists, Tailors, Weavers, VDT Operators

Cumulative trauma disorder (CTD) is a term used to describe a class of soft tissue injuries and disorders that are caused, precipitated or aggravated by a number of occupational activities. These disorders are frequently observed among workers who perform hand intensive jobs¹. Occupational exposures such as highly repetitive hand exertions, vibrations and localized mechanical pressure are considered to be factors contributing to the occurrence of CTD². CTDs develop over time due to repetitive stress applied to a joint, typically the upper extremities^{3,4}. The association of CTDs with various industrial works has been found in the UK. The study revealed that upper limb disorders rank second only to back complaints in various work organization in the UK. It was also reported that among workers, who were exposed to repetitive work for a long time, the occurrence of CTD was found to be very high⁵. In developing countries like India, no attention is given to the health and safety of the workers in unorganized sectors. No previous study on CTD has been performed in India by the government or any private organization, so that these people in unorganized sectors, working in highly repetitive job, remain deprived of the opportunity to work in better environmental conditions. According to Silverstein⁶ an activity is said to be repetitive if 50% of the work cycle involves similar motion patterns.

In the present investigation, an attempt was made to determine the prevalence of CTD among workers in hand intensive jobs in unorganized sectors in India and to highlight the unsafe working conditions to which these workers are being exposed for years.

Received Dec 24, 2002; Accepted Sep 4, 2003

Correspondence to: S. Gangopadhyay, Department of Physiology, Ergonomics Laboratory, University College of Science and Technology, University of Calcutta, 92 A.P.C. Road Calcutta 700 009, India

Materials and Methods

Selection of Subjects: In this study, the experiment was performed on 5 different groups of workers, each group contains 25 male workers, viz.

Meat Cutters, Typists, Tailors, Visual Display Terminal (VDT) Operators and Weavers.

To avoid selection bias, all the workers in each group were selected randomly from different areas of West Bengal. In our random selection, we did not find any worker who had less than one year's experience.

Questionnaire Study: A questionnaire was developed and applied which included a number of questions emphasizing individual details, type of work, CTD symptoms, work posture, Multi-Method Ergonomic Review Technique (MMERT), etc., to investigate the feeling of discomfort. MMERT is a subjective scaling method ranging from 0 to 5 where each digit represents a statement mentioned below:

- 0-Do not know the answer to the question Or Not applicable;
- 1-Strongly Disagree;
- 2-Disagree;
- 3-Neither Agree nor Disagree;
- 4-Agree;
- 5-Strongly Agree.

In our present study this type of questionnaire was applied to evaluate the general physical activity, task variety and working environment of the workers.

A study on repetitiveness included the analysis of time and motion in work. Total time taken for a particular job (for example, meat cutting, tailoring, typing, VDT operation and weaving) was recorded. Different activities that constitute that particular job were also recorded. The time taken for the completion of each activity was noted. The main activity was considered to be that activity which occupied more than 50% of total time. The result will confirm the repetitiveness of the work.

Subjective Symptoms in the Musculo-skeletal System: In this part of the questionnaire the participants were interviewed about any kind of discomfort felt in the body, such as the hand, wrist, upper arm, lower arm, lower extremities, etc. The intensity of pain or discomfort was measured by utilizing the body part discomfort (BPD)

scale⁷. The rating of each body part on a scale from 1 to 10 was done to indicate the level of discomfort. Workers with no such feeling of discomfort were not included in this rating.

Checklist Fundamentals: A checklist was structured to utilize 5 categories of ergonomic risk factors associated with CTDs i.e. repetitiveness, local mechanical stress, forceful exertions, awkward posture, defective tool use².

Statistical Analysis: A proper statistical method was used to find out the association between feeling of discomfort and repetitiveness of work. For this study a two-tailed chi-square test of independence was applied to determine whether or not the feeling of discomfort had any significant association with the repetitiveness of the work. The frequencies of paired observations were first arranged into a 2 × 2 contingency table showing the combined distribution of the variables. Yates' correction was applied wherever required. The computed χ^2 was next compared with the critical χ^2 value for the chosen level of significance ($p < 0.05$)⁹.

Results

From the analysis of the questionnaire, results are developed in tabular forms. Table 1 represents the average years of experience of the workers engaged in individual occupations. Most of the meat-cutters, tailors, typists, VDT operators and weavers have been working for more than 10 yr. The mean duration of work per day as well as the number of working days in a week are shown in Table 2. The average working hours per day of the weavers are 10 h and for the meat cutters and tailors more than 10 h. In the case of typists and VDT operators the working hours are more than 7 h per day. The working days in a week are found to be 6 d for all the subjects, excepting the weavers who worked the entire week. Table 3 represents the feeling of discomfort (any level of discomfort according to the BPD scale) as well as no feeling of discomfort of the workers. Eighty percent (80%) of the meat cutters, 84% of both the tailors and typists, 88% of the VDT operators and 92% of the weavers reported feeling discomfort. The feeling of discomfort in different body parts in each individual group of workers is shown in Table 4. It is observed that the feeling of discomfort in different body parts varied among the workers. In the

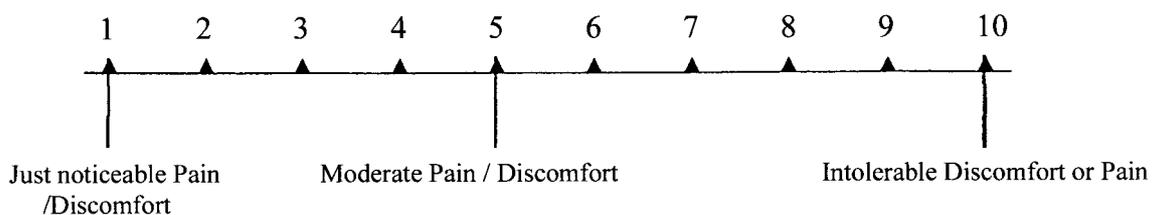


Table 1. Mean age and average years of experience

Occupation	Age (\pm SD)	1–5 yr	6–10 yr	>10 yr
Meat cutters	41.9 (\pm 6.84)	2 (8.0%)	5 (20.0%)	18 (72.0%)
Tailors	42.1 (\pm 7.71)	2 (8.0%)	10 (40.0%)	13 (52.0%)
Typists	45.9 (\pm 5.83)	3 (12.0%)	5 (20.0%)	17 (68.0%)
VDT Operators	49.3 (\pm 4.85)	1 (4.0%)	5 (20.0%)	19 (76.0%)
Weavers	35.7 (\pm 6.38)	2 (8.0%)	8 (32.0%)	15 (60.0%)

Table 2. Mean duration of work per day and average number of working days in a week

Occupation	Duration of work per day (in hours)		Number of working days in a week
	Mean	SD	
Meat cutters	10.4	\pm 2.1	6
Tailors	10.4	\pm 1.0	6
Typists	7.4	\pm 1.1	6
VDT Operators	8.0	\pm 1.1	6
Weavers	10.0	\pm 1.3	7

Table 3. Discomfort and no discomfort feeling in the workers

	Meat cutters	Tailors	Typists	VDT Operators	Weavers
Discomfort	20 (80%)	21 (84%)	21 (84%)	22 (88%)	23 (92%)
No Discomfort	5 (20%)	4 (16%)	4 (16%)	3 (12%)	2 (8%)

Table 4. Discomfort feeling in body parts

Body parts	Meat cutters	Tailors	Typists	VDT Operators	Weavers
Neck	NIL	NIL	NIL	19 (86.4%)	NIL
Shoulder	NIL	2 (9.5%)	6 (28.6%)	15 (68.2%)	8 (34.8%)
Upper arm	12 (60.0%)	NIL	2 (9.5%)	5 (22.7%)	10 (43.5%)
Lower arm	11 (55.0%)	NIL	NIL	NIL	NIL
Wrist	15 (75.0%)	4 (19.1%)	7 (33.3%)	12 (54.6%)	18 (78.3%)
Hand	15 (75.0%)	4 (19.1%)	6 (28.6%)	12 (54.6%)	19 (82.6%)
Fingers	15 (75.0%)	NIL	NIL	NIL	3 (13.0%)
Upper back	NIL	2 (9.5%)	8 (38.1%)	7 (31.8%)	2 (8.7%)
Low back	NIL	17 (81.0%)	13 (61.9%)	13 (59.1%)	5 (21.7%)

Percentages of total number of workers having feelings of discomfort are shown in parenthesis.

case of the meat cutters the feeling of discomfort mostly involve the wrist (75%), hand (75%) and fingers (75%). In the case of the tailors maximum discomfort occurs in the lower back (81%). The typists also suffer mostly from lower back discomfort (61.9%). It is noted that the VDT operators largely suffered from discomfort affecting

the neck (86.4%). In case of the weavers maximum discomfort occur in the hand (82.6%) region. Table 5 shows the types of discomfort, mainly pain, numbness, swelling and stiffness, experienced by the workers engaged in their respective occupations. It is revealed that all the workers mostly complained of pain only in

Table 5. Responses on different types of discomfort feelings

Types of discomfort	Meat cutters	Tailors	Typists	VDT Operators	Weavers
Pain	15 (75.0%)	17 (81.0%)	13 (61.9%)	18 (81.8%)	17 (73.9%)
Numbness	8 (40.0%)	NIL	4 (19.0%)	1 (4.5%)	6 (26.1%)
Swelling	8 (40.0%)	NIL	NIL	5 (22.7%)	3 (13.0%)
Stiffness	11 (55.0%)	5 (23.8%)	5 (23.8%)	5 (22.7%)	7 (30.4%)

Percentages of total number of workers having feelings of discomfort are shown in parenthesis.

Table 6. Repetitiveness in main activity in different occupations

Occupation	Main activity	Time taken (in sec)		Total time taken in one work cycle (sec)		Repetitive/ Non-repetitive
		Mean	SD	Mean	SD	
Meat cutters	Chopping	45.5	± 13.2	76.9	± 13.6	R
Tailors	Sewing	35.0	± 21.2	58.4	± 29.7	R
Typists	Typing	48.0	± 14.4	63.8	± 15.4	R
VDT Operators	Data entry	40.0	± 27.8	67.1	± 26.4	R
Weavers	Weaving	369.0	± 8.0	522.0	± 6.5	R

Time Taken: This means the time required to perform the main activity which is a part of a single work cycle.

Total Time Taken in one Work Cycle: This means the time spent for the completion of a single work cycle which involves the sequence of activities that are required to perform a job including the main activity.

Table 7a. 2 × 2 Contingency table showing relation between repetitiveness of work and feeling of discomfort in meat cutters

Body discomfort scale	Repetitiveness of work		Total (fr)
	Above 50%–70% of total work cycle	Above 70% of total work cycle	
1–5	7 (B)	1 (A)	8 (A+B)
6–10	1 (D)	11 (C)	12 (C+D)
Total (fc)	8 (B + D)	12 (A+C)	20 (N)

$$\chi^2=9.45 \quad (p<0.05)$$

Table 7b. 2 × 2 Contingency table showing relation between repetitiveness of work and feeling of discomfort in tailors

Body discomfort scale	Repetitiveness of work		Total (fr)
	Above 50%–70% of total work cycle	Above 70% of total work cycle	
1–5	10 (B)	2 (A)	12 (A+B)
6–10	2 (D)	7 (C)	9 (C+D)
Total (fc)	12 (B+D)	9 (A+C)	21 (N)

$$\chi^2=5.55 \quad (p<0.05)$$

Table 7c. 2 × 2 Contingency table showing relation between repetitiveness of work and feeling of discomfort in typists

Body discomfort scale	Repetitiveness of work		Total (fr)
	Above 50%–70% of total work cycle	Above 70% of total work cycle	
1–5	6 (B)	2 (A)	8 (A+B)
6–10	2 (D)	11 (C)	13 (C+D)
Total (fc)	8 (B+D)	13 (A+C)	21 (N)

$$\chi^2 = 5.15 \quad (p < 0.05)$$

Table 7d. 2 × 2 Contingency table showing relation between repetitiveness of work and feeling of discomfort in VDT operators

Body discomfort scale	Repetitiveness of work		Total (fr)
	Above 50%–70% of total work cycle	Above 70% of total work cycle	
1–5	11 (B)	2 (A)	13 (A+B)
6–10	2 (D)	7 (C)	9 (C+D)
Total (fc)	13 (B+D)	9 (A+C)	22 (N)

$$\chi^2 = 6.18 \quad (p < 0.05)$$

Table 7e. 2 × 2 Contingency table showing relation between repetitiveness of work and feeling of discomfort in weavers

Body discomfort scale	Repetitiveness of work		Total (fr)
	Above 50%–70% of total work cycle	Above 70% of total work cycle	
1–5	7 (B)	1 (A)	8 (A+B)
6–10	1 (D)	14 (C)	15 (C+D)
Total (fc)	8 (B+D)	15 (A+C)	23 (N)

$$\chi^2 = 11.68 \quad (p < 0.05)$$

different body parts and the meat-cutters also suffered from stiffness. But few of them complained of numbness and swelling. Repetitiveness of the main activity in all the different occupations is shown in Table 6.

2 × 2 contingency tables showing the association between repetitiveness of work and discomfort in all the groups are shown in Table 7 (a–e). In each of these tables, the two rows represent the body part discomfort scale ranging 1–5 and 6–10 respectively, whereas the two columns represent the repetitiveness of work involving 50% to 70% and above 70% of the total work cycle, respectively.

Discussion

From the observation of the working conditions of the unorganized sector, it was evident that the workers have to work in a congested work place and in a restricted work area. They work under very poor illumination and are usually exposed to a high noise level around 80–90 dB in daytime because most of the work areas are situated near the roadside. Most of the working groups experienced a high ambient temperature and high humidity level in summer season with a radiant heat level around 40°C.

From the analysis of the results, it was revealed that the meat cutters, tailors, typists, VDT operators and

weavers have been engaged in their respective occupations ever since they started earning their livelihood. In India the unorganized sectors are not bound to follow the Governmental rules and regulations (i.e., 8 h of work per day with a weekly day off). The workers have a low socio-economic status. They work according to the job demands and more work provides them with the opportunity to earn more. These data clearly indicate that among the sample chosen at random, the majority of the workers have been exposed to the various risk factors for CTD such as forceful exertion and mechanical stress for quite a long period.

It was clearly revealed that most of the workers in all the groups suffered from discomfort in different body parts. This can be attributed to their prolonged working hours, remaining in a constant posture and repetitiveness of the work.

In the case of tailors, sewing machine operation occupies the major portion of the work cycle. In the case of meat cutting activity—a highly repetitive activity—non-neutral wrist posture, flexion, extension, forceful exertion with heavy tool use for long periods are the main causes of upper extremity CTD. The heavy chopper they use for long periods is not ergonomically designed, as it causes maximum flexion and extension which leads to CTD. This fact has already been supported by Kurpa and Juntara⁸⁾, who reported that meat cutting has long been associated with the occurrence of CTDs. The data obtained from the work of Marklin and Monrie¹⁰⁾, revealed that CTDs are highly prevalent amongst meat cutters. In the case of weaving activity, arrangement of thread for these weavers could be regarded as a repetitive activity. It was found that long-term sewing work placed a cumulative load on musculoskeletal structures including the vertebral column¹¹⁾. Many VDT users develop chronic neck, shoulder, arm, wrist and hand pain problems commonly known as repetitive strain injury (RSI), cumulative trauma disorder (CTD) or overuse syndrome (OS), from long hours of repetitive tasks involving extensive keyboard and mouse operation. For VDT users-painful musculoskeletal disorders are a common and major cause of lost productivity, work-related disability and escalating employee health care costs. According to Silverstein⁶⁾ an activity is said to be repetitive if 50% of the work cycle involves similar motion patterns. This criterion of repetitiveness was satisfied in this study whereby in all the cases over 50% of their work cycle involved the respective main activity where similar kind of motion patterns were involved.

It was clearly observed from the statistical analysis that there exists a highly significant association between repetitive work and feeling of discomfort in all the groups. High repetitiveness may be regarded as a causative factor for the occurrence of CTD. Prolonged work activity and remaining in a static posture for prolonged periods may

also be related to the occurrence of CTD.

Recommendations: Considering the socio-economic status of these workers, the following suggestions were made to improve their working conditions at low cost.

- 1) The work period should be modified, with short rest pauses in their work schedule, which may improve their efficiency.
- 2) Enough flexibility and adjustability should be incorporated in the workplace to allow workers to make postural changes easily.
- 3) Exhaust fans should be installed to decrease the heat load of the work environment.
- 4) Natural ventilation and proper air circulation should be achieved to improve overall ventilation.
- 5) By installing skylights natural illumination in the workplace can be improved.
- 6) Some artificial light sources in the right places should be installed to increase the illumination in the working area.
- 7) Hearing protectors (e.g. earplugs, ear muffs) should be used to check the stress caused due to excessive noise.
- 8) Proper knowledge and education should be provided for the workers for the betterment of their health.

Acknowledgments: The authors express their sincere gratitude to all those workers who rendered immense cooperation during the completion of this study.

The authors also like to thank the "All India Council Of Technical Education" (AICTE), New Delhi for their partial financial assistance in this present study.

References

- 1) Armstrong TJ. Ergonomics and cumulative trauma disorders of the hand and wrist. *In:* Hunter JM, Schneider LH, Mackin EJ et al., eds. *Rehabilitation and Surgery of the Hand*. Philadelphia: Mosby, 1990: 1175–1191.
- 2) WM Keyserling, DS Stetson and BA Silverstein: A checklist for evaluating ergonomic risk factors associated with upper extremity cumulative trauma disorders. *Ergonomics* 36, 807–831 (1993)
- 3) Putz-Anderson V. *Cumulative trauma disorders*. London: Taylor & Francis Ltd, 1988.
- 4) KHE Kroemer: Cumulative trauma disorders: their recognition and ergonomic measures to avoid them. *Applied Ergonomics* 20, 274–280 (1989)
- 5) JM Muggleton, R Allen, and PH Chappel: Hand and arm injuries associated with repetitive manual work in industry: a review of disorders, risk factors and preventive measures. *Ergonomics* 42, 714–739 (1999)
- 6) BA Silverstein, LJ Fine, and TJ Armstrong: Occupational factors and CTS. *American Journal of Industrial Medicine* 11, 343–358 (1987)
- 7) LR Jacquelin, G Drury, and LB Richard: A field methodology for the control of musculoskeletal

- injuries. *Applied Ergonomics* 25, 3–16 (1994)
- 8) K Kurpa, and E Viikari-Juntura: Incidence of tenosynovitis or peritendinites and epicondylitis in a meat processing factory. *Scandinavian Journal of Work and Environmental Health* 17, 32–37 (1991)
 - 9) Das D and Das A. *Statistics in Biology & Psychology*. Calcutta: Academic Publishers 1993.
 - 10) RW Marklin and JF Monrie: Quantitative biomechanical analysis of wrist motion in bone-trimming jobs in the meat packing industry. *Ergonomics* 41, 227–237 (1998)
 - 11) A Nag, H Desai, and PK Nag: Work stress of women in sewing machine operation. *Journal of Human Ergology* 21, 47–55 (1992)