J. Human Ergol., **32**: 17-22, 2003

A STUDY ON THE PREVALENCE OF UPPER EXTREMITY REPETITIVE STRAIN INJURIES AMONG THE HANDLOOM WEAVERS OF WEST BENGAL

PRASUN BANERJEE AND SOMNATH GANGOPADHYAY*

*Ergonomics and Work Physiology Laboratory, Department of Physiology, University College of Science and Technology, University of Calcutta, 92, A.P.C. Road, Calcutta-700 009, India /*Email: ria10gan@vsnl.net*

Handloom is one of the oldest cottage industries in India, particularly in West Bengal, where a considerable number of rural people are engaged in weaving. Purposes of the present investigation were to clarify the prevalence of repetitive strain injuries in upper extremities among the handloom weavers and to identify the risk factors leading to its development. Fifty male handloom weavers were randomly selected from the population. A questionnaire (Kourinka et al., 1987) method including Borg scale assessment of pain, checklist analyses of the work, and time-motion studies for analyzing the repetitiveness/non-repetitiveness of the job were implemented. The time-motion analyses demonstrated that weaving occupied over 50% of the work cycle time for majority of subjects, and thus could be regarded as a repetitive activity. Statistical analyses revealed a highly significant correlation between the intensity of pain feeling and the repetitiveness on one hand, and the year of experience as a weaver on the other. By contrast, no significant relationship was observed between chronological ages of weavers and the pain intensity. These results suggested that highly repetitive works engaged for a long time could increase the intensity of the pain felt and would lead to repetitive strain injuries.

Key Words: handloom weavers; west bengal; repetitive strain injuries; upper extremity trauma disorders

INTRODUCTION

Occupational diseases cover all pathological conditions induced by prolonged work, excessive exertion, or harmful factors inherent in materials, equipments, or working environments. Furthermore, there are diseases which are caused by a etiological factors inherent in the circumstances in which the work is done, such as bad posture, repeated physical effort, or psychological stresses, and therefore, would deserve to be recognized as occupational diseases.

Musculo-skeletal disorders (MSD) are the most common self-reported work-related illness. They are manifestations of the ergonomic hazards and are the leading cause of disability of people during the working years. According to Levy and Wegman (1988), occupationally caused or aggravated MSDs rank first among the health problems in the frequency with which they affect the quality of life. They affect nearly one half of the nation's workforce at sometime, resulting in time lost from work. Based on lost earnings, workers' compensation payments and medical payments, MSDs are more costly than any other single health disorder.

Work- related musculo-skeletal injuries generally inflict the muscles, ligaments, tendons or nerves, and occur when excessive stresses are placed on a human's musculo-skeletal system. A majority of these injuries are the result of repeated stress (Kroemer, 1989).

Chronic MSDs in the upper limbs (also known as repetitive strain injuries or cumulative trauma disorders) continue to have an important place in reported illness suffered in the work place. Cumulative trauma disorders (CTDs) develop over time due to repetitive stress to a joint, typically in the

Received for publication July 6, 2002

upper extremities (Putz-Anderson, 1988; Kroemer, 1989). These disorders are frequently observed in the nerves, tendons, tendon sheaths and muscles of upper extremities of workers who perform hand intensive jobs (Armstrong, 1990). Occupational exposure such as highly repetitive hand exertions, vibrations and localized mechanical pressure are considered to be contributing factors towards the occurrence of CTDs. In many hand intensive jobs, more than one of these risk factors may be present (Keyserling et al., 1993). They are a major cause of lost time and workers' compensation payments in many hand intensive jobs.

Handloom is the oldest cottage industry in India, which is unorganized in nature. In West Bengal in particular, a large number of rural populations are directly involved in weaving. The main activities of the handloom weavers are weaving, cutting, starching, adjustment of handloom, arrangement of thread, and spindle insertion. Handloom weavers belong to a very low socioeconomic group. They get some amount of initial government aids to purchase handloom and raw materials to start their profession. These aids are not sufficient for their future establishment. Moreover, a large number of weavers have no handloom of their own. They work under weavers who have their own handlooms, in a very low salary. Handloom weavers work hard for their livelihood in a very small room with minimum ventilation and low illumination.

So far as our knowledge is concerned, however, no previous study has been made in India to find out the occupational health problems of weavers working such long hours in poorly ventilated and illuminated conditions. In the present study, we attempted to evaluate the prevalence of repetitive strain injuries (RSIs) among the weavers and to investigate the contributing factors. Through this study, local awareness regarding occupational safety and health of workers working in unorganized sectors can be increased to improve the present occupational safety and health situation in India.

METHODS

Subjects and Procedures

Fifty male workers engaged in handloom weaving were randomly selected for the study. The methods chosen to carry out this study were the measurements of subjects' physical parameters, survey of occupational backgrounds and subjective symptoms of the subjects through the questionnaire method, Borg scale assessment of pain, the checklist analysis of the working situations, and time-motion study of the different activities during a work cycle.

Each subject was approached by the experimenter for explaining the aim of study in a layman's term. Only on acceptance from the subject, the interview started on the basis of the questionnaire before the start of daily work, while the height and weight of the subjects were recorded with anthropometer and weighing machine, respectively. The filled-up questionnaires were then put to statistical analyses.

Questionnaires

The questionnaire (Kourinka et al., 1987) was designed to function as sensitive, rapid screening tool, which could identify the risk factors of the handloom weavers that could lead to upper extremity repetitive strain injuries. The questionnaire was composed of a series of objective questions with multiple-choice responses. The questions were grouped into sections dealing with physical parameters of the weavers, their occupational backgrounds, and subjective symptoms in the musculoskeletal system or details in the work-related pain. The occupational backgrounds included the years in which each subject was engaged in the weaving, the working time in a day, the working days in a week, and non-occupational activities. Subjective symptoms included any kind of discomfort felt in the body, such as hands, wrist, shoulder, neck, low back, lower extremities etc., during work and also during rest. The questions were also addressed whether the subjects experienced pain or discomfort after work, viz. stiffness, numbness or tingle, or any kind of swelling. Intensity of the pain was assessed by using Borg scale (Borg, 1982).

Checklist analysis

The checklist analysis served as an evaluation tool. It was designed to identify the activities of the subjects with potentially harmful exposure to the following ergonomic risk factors:

1)Repetitiveness: Repetitiveness has been frequently cited as a risk factor associated with the development of upper extremity CTDs. The checklist questions, along with the time record of the different activities were used to evaluate repetitiveness.

2)Localized mechanical stress: Localized mechanical stresses are caused by physical contact between soft body tissue and an object or tool in the working environments. Checklist observations were used to evaluate the mechanical stresses.

3)Forceful exertions: Forceful hand exertions during work activities such as using heavy tools have been associated with increased risk of upper extremity CTDs (Silverstein et al., 1987). A few checklist observations were used to evaluate working conditions associated with forceful hand exertions.

4)Awkward posture: Working posture is influenced by the interaction of many occupational and individual factors. The checklist observations were used to identify the occurrence of awkward postures such as flexion, extension, and ulnar or radial deviation.

5)Exposure to vibration: Exposure of the upper extremities to segmental vibration have been cited as casual factors for decrements of manual dexterity, decreased grip strength, and the development of CTDs (Armstrong, 1990). Tool use can also require forceful hand exertions, particularly if the tool generates high vibration. The checklist questions screen ergonomic exposure to segmental vibration.

Time-motion analysis of the repetitiveness of work

During the time study, the entire tasks of the handloom weavers were recorded through video photography (Sony Handycam TRV 87 Digital Zoom 360x). The time taken for different activities by the subjects was recorded by means of stopwatches. These data were used to analyze repetitiveness / non-repetitiveness of a particular activity. According to the definitions of Silverstein et al. (1987), an activity was judged to be repetitive if the basic cycle time was less than 30 sec and /or over 50% of the work cycle involved similar upper extremity motion patterns.

Statistical analysis

Pearson's product moment correlation coefficient (r) and student's t-test were applied to determine whether any significant association was present between the following test items or not; a) pain *vs*. repetitiveness; b) pain *vs*. year of experience of the subjects; c) pain *vs*. age of the subjects.

RESULTS AND DISCUSSION

Table 1 shows the age and physical characteristics of the handloom weavers examined. Our subjects have similar body structures as those of an average Bengalese of West Bengal (Chakrabarti, 1997). The questionnaire has revealed that all the subjects work 7 days a week and 10 hours a day. All the subjects also have been engaged in weaving ever since they started earning their livelihood. Table 2 summarizes the years of subjects' experience in weaving. A majority of the subjects (62%) has been working for more than 10 years, which means that they have been exposed to various risk factors because, as shown above, their working time is 10 hours a day and 7 days a week. Every day they take a break of 1 hour to take lunch and tea, as an addition to their total working time of 10 hours.

Table 3 presents the incidence of the discomfort feeling in different parts of the body. It is evident that more than one third of the subjects have discomfort in the upper limb, and the incidence amounts to more than 70% in the hand and wrist. These data suggest possible occurrence of musculoskeletal disorders in the upper extremities among the weavers. Further detailed analysis of discom-

Table 1. Physical characteristics of handloom weavers (n=50).

		Mean	SD	Range
Height	(cm)	161.8	± 5.1	151.5 - 169.0
Weight	(kg)	51.7	± 8.4	38.0 - 81.0
BMI	(kg/m^2)	19.7	± 2.8	14.6 - 28.5
Age	(years)	35.7	±10.7	20 - 60

Table 2. Number and % (in parenthesis) of subjects with different years of experience in weaving.

	1yr.-5yrs.	6yrs.-10yrs.	>10yrs.
Number and % (in parenthesis) of subjects	4 (8)	15 (30)	31 (62)

Table 3. Number and % (in parenthesis) of handloom weavers complaining discomfort in different parts of the body.

	Number	(%)
Hand	42	(84)
Wrist	38	(76)
Upper arm	21	(42)
Shoulder	18	(36)
Ankle	15	(30)
Foot	14	(28)
Back (lower)	11	(22)
Knee	10	(20)
Finger	7	(14)
Back (upper)	5	(10)
Other parts	3	(6)

fort feeling in the hand is presented in Table 4. Thus, accepting the responses to be true, it is seen that a substantial percentage of the weavers suffer from discomfort in the upper extremities. The feeling of pain at night after work may indicate chances of RSIs. Our findings appear to be related with those obtained by Leelerc et al. (1998) that RSIs are associated with such industries as installing assembly line, clothing and shoe industry, and food industry.

Survey of the stress in the upper extremities caused by repetitiveness was carried out where the repetitiveness was judged with the help of time-motion study. Table 5 gives the time taken in different activities using the upper extremities by the handloom weavers during working. Percentages of the work cycle involved in similar motion pattern are also given. Based on the definitions of Silverstein et al. (1987) mentioned above, all the handloom weavers (50 out of 50) satisfied the criteria for

Table 4. Number and % (in parenthesis) of handloom weavers complaining discomfort in the right hand.

	Number	(%)
Pain	36	(72)
Stiff	16	(32)
Numb / Tingle	12	(24)
Swell	7	(14)
Pain at night	12	(24)
Strength of hands decreased	35	(70)
Intensity of pain increased	22	(44)
Frequency of pain increased	19	(38)

Table 5. Time taken(sec), its percentage against total working time (in parenthesis), and repetitiveness (R) / non-repetitiveness (NR) of handloom weavers.

	Mean	(%)	SD	Range	R / NR
Weaving	369.5	(61.6)	±17.1	328 – 421	R
Cutting	46.1	(7.7)	± 7.6	28 – 69	NR
Straching	63.7	(10.6)	±11.9	43 – 87	NR
Adjustment of handloom	28.2	(4.7)	± 7.3	16 – 44	NR
Arrangement of thread	53.1	(8.9)	±11.1	30 – 89	NR
Spindle insertion	29.3	(4.9)	± 7.1	16 – 48	NR
Other activities not related to weaving	10.6	(1.7)	± 3.7	4 – 19	NR

repetitiveness, i.e. over 50% of their work cycle consisted of the activity of weaving where similar kind of motion patterns were involved. On the other hand, other activities like cutting, starching, adjustment of handloom, arrangement of thread, and spindle insertion have been found totally non-repetitive. The time-motion analysis also has demonstrated that non-linear wrist postures were adopted in the activity of weaving.

Table 6 shows the results of correlation analysis between the discomfort, represented by pain intensity, and three different variables. The analysis has revealed that there is a moderate but highly significant relationship between the pain intensity and repetitiveness ($p<0.001$), or the year of experience of the weavers ($p<0.01$). By contrast, the pain intensity has no significant correlation with the age of subjects ($p>0.1$). Our data clearly have proved that the weavers, who have been long exposed to the repetitive work, i.e. weaving, are highly responsive to discomfort. These results are compatible with those of Muggleton et al. (1999) in which the occurrence of CTD was very frequent among the workers exposed to repetitive works for long time. Highly repetitive works may directly damage tendons through repeated stretching and elongation as well as increase the likelihood of fatigue and decrease the opportunity for tissues to recover (Silverstein et al., 1987; Armstrong, 1990).

Among the occupational factors that contribute toward the occurrence of RSIs, repetitive and forceful motions are considered as most important ones followed by awkward posture of the upper extremities. Our study has demonstrated the possibility that the discomfort feeling in the hand-wrist portions of the weavers are caused by the long-term exposure to highly repetitive works as well as

Table6. The relation between the intensity of pain and age, years of experience, and repetitiveness of work in handloom weavers.

	Mean	SD	
Pain intensity	5.36	±1.61	r*=0.20
Age of the weaver	35.7	±10.7	t=1.414
			NS
Pain intensity	5.36	±1.61	r*=0.37
Years of experience	15.6	±10.7	t=2.759
			S ($p \leq 0.01$)
Pain intensity	5.36	±2.84	r*=0.49
Repetitiveness of work	61.59	±1.61	t=3.894
			S ($p \leq 0.001$)

* Pearson's product moment correlation coeffcient; S: statistically significant; NS: statistically nonsignificant

non-linear wrist postures. Job enrichment, i.e. adding more task to an individuals jobs to increase the length of basic work cycle, job rotation, or increasing the rest pauses by providing short interim breaks between two consecutive work cycles, would help to effectively minimize these conditions. Weavers' discomfort may also be reduced by enhancing the linearity in the hand-wrist postures during working. This can be done by modifying the existing handloom design ergonomically.

The authors express their sincere gratitude to Mr. Goutam Ghoshal and Mr. Tamal Das, Research Scholars of Ergonomics Laboratory, Department of Physiology, University of Calcutta, for their immense help and gracious cooperation towards the completion of the present research work. The authors also like to thank all those handloom weavers who rendered immense cooperation during the completion of this study.

REFERENCES

Armstrong, TJ (1990) Ergonomics and cumulative trauma disorder of the hand and wrist. *In*: Rehabilitation of the Hand, Surgery and Therapy. The C.V. Mosby Co., Philadelphia: pp. 1175-1191.

Borg, GAV (1982) Psycophysical bases of perceived exertion. *Med. Sci. Sports Exerc.*, **14**: 377 - 381.

Chakrabarti, D (1997) Indian Anthropometric Dimentions for Ergonomic Design Practice. National Institute of Design, Ahmedabad.

Keyserling, WM, Stetson, DS, Silverstein, BA, and Brower, ML (1993) A checklist for evaluating ergonomic risk factors associated with upper extremity cumulative trauma disorders. *Ergonomics*, **36**: 807-831.

Kourinka, I, Jonsson, B, Kilbom, A, Vinterberg, H, Biering-Sorensen, F, Andersson, G, and Jorgensen, K (1987) Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms. *Appl. Ergon.*, **18**: 233-237.

Kroemer, KHE (1989) Cumulative trauma disorders: their recognition and ergonomic measures to avoid them. *Appl. Ergon.*, **20**: 274-280.

Leclerc, A, Franchi, P, Cristofari, MF, Delemotte, B, Mereau, P, Jeyssier-Cotte, C, and Jourauchet, A (1998) Carpal tunnel syndrome and work organization in repetitive work: a cross-sectional study in France. Study group on repetitive work. *Occupational and Environmental Medicine*, **55**: 1807-1817.

Levy, BS and Wegman, DH (1988) Occupational Health - Recognizing and Preventing Work-Related Disease and Injury. Lippincott Williams and Wilkins, Philadelphia.

Muggleton, JM, Allen, R, and Chappel, PH (1999) Hand and arm injuries associated with repetitive manual work in industry: a review of disorders, risk factors and preventive measures. *Ergonomics*, **42**: 714-739.

Putz-Anderson, V (1988) Cumulative Trauma Disorders. Taylor and Francis Ltd., London.

Silverstein, BA, Fine, LJ, and Armstrong, TJ (1987) Occupational factors and CTS. *Am. J. Industr. Med.*, **11**: 343-358.