

# Prevalence of Upper Limb Musculo Skeletal Disorders among Brass Metal Workers in West Bengal, India

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**Abstract:** Brass metal work is one of the oldest cottage industries in West Bengal, India. Workers performing rigorous hand intensive jobs are likely to suffer from MSD affecting the upper limbs. The present investigation was intended to establish the prevalence of upper limb MSD among the brass metal workers and to identify the causative factors behind its development. In this study, 50 male brass metal workers (Experimental Group) and 50 male office workers (Comparison Group) were selected. For the symptom survey, a questionnaire on discomfort symptoms was performed. Repetitiveness of work and Hand Grip Strength of both the groups were measured. It was revealed that upper limb MSD was a major problem among brass metal workers, primarily involving the hand, wrist, fingers and shoulder. Among the workers reporting subjective discomfort, most of them felt pain, followed by tingling and numbness in their hands. Many complained of swelling, warmth and tenderness in their wrists. Their activities were highly repetitive and the handgrip strength of these workers was significantly less than that of the comparison group. Based on these findings, it appears that high repetitiveness, prolonged work activity (10.5 h of work per day with 8.4 h spent on hammering) and decreased handgrip strength may be causative factors in the occurrence of upper limb MSD among brass metal workers in West Bengal, India.

**Key words:** Musculo skeletal disorders, Upper Limb, Repetitiveness, Grip strength, Brass metal workers

## Introduction

Musculo-skeletal disorders (MSD) may be defined as injuries and disorders of the muscles, nerves, tendons, ligaments, joints, cartilage and spinal disc. This may occur due to improper physical work activities or appalling workplace conditions. MSDs can be caused by heavy physical work, static work postures, frequent bending and twisting, lifting, pushing and pulling, repetitive work, vibration and psychological and psychosocial stress<sup>1, 2</sup>.

Musculoskeletal disorders are the most common self-reported work-related illness. They are the manifestations of ergonomic hazards and are the leading causes of disability

among the people during their working years. According to Levy and Wegman<sup>3</sup> occupationally caused or aggravated MSD rank first among health problems in the frequency with which they affect quality of life. Workers performing rigorous hand intensive jobs are likely to suffer from MSD affecting the upper limbs. Occupational exposures involving highly repetitive jobs with grasping of the hands, repetitive bending of the wrist, vibration and localized mechanical pressure are considered to be contributing factors towards the occurrence of this disorder<sup>4</sup>. Crouch<sup>5</sup> suggested that handgrip strength is a useful diagnostic tool to determine work-related upper extremity musculoskeletal disorders such as Carpal Tunnel Syndrome (CTS). Decreased grip strength may make it difficult to form a fist, grasp small objects, or perform other manual tasks. The existence of MSD in upper

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limbs can be detected by examining pain, numbness and tingling in the hands and tenderness, swelling and warmth in the wrists<sup>5</sup>. An association of MSD with various industrial work has been found in UK<sup>6</sup>. This study revealed that upper limb disorder rank second only to back complaints in various work organization in UK. It was also reported that the workers, who were exposed to repetitive work for long time, the occurrence of MSD was found to be very high among them.

Brass metal work is one of the oldest cottage industries in India, particularly in West Bengal. Although these types of work were practiced throughout West Bengal for many years, in recent times they are carried out in the central part of West Bengal in places like Nabadwip and Berhampore. In this job household utensils are prepared in a large scale. At first, a sheet of brass metal is continuously hammered manually for giving shape and then the utensils are designed by engraving with cutters. Finally they are polished and made ready for sale. As hammering is the most predominant activity in the entire work process, a large number of workers are engaged in this activity. Although brass metal work are carried out for so many years, yet no such study on these works has been reported so far. Moreover it has been reported that many workers in the Berhampore region have left their jobs in the last few years primarily due to work-related upper limb MSDs. Thus in the present study, the prevalence of upper limb MSD among these brass metal workers associated with strenuous hand intensive jobs will be evaluated by comparing with office bearers involved in minimally hand intensive jobs.

## Materials and Methods

### *Subjects*

The study was performed on 50 male brass metal workers, designated as the experimental group, engaged in rigorous hand intensive jobs including hammering (weight of each hammer on an average is 2.5 kg). Since the number of such workers had undergone a steady decline over the years, out of the existing 150 workers, 50 were chosen for the study. To avoid selection bias, workers were selected randomly from the Berhampore subdivision of West Bengal. The workers were first selected in the age range of 27–42 yr and then 50 workers were selected from them by lottery (Table 1). This subdivision was specifically chosen because brass metal works are predominantly carried out in this subdivision and are done by only male workers. Another 50 male office bearers, who are not involved in constant hand intensive jobs, were selected as a comparison group for this study.

The office bearers are responsible for the arrangement of files, distribution of documents in different sections of the office and serving tea, water, foodstuffs to staff members on request. Both the experimental and the comparison groups belong to the same socioeconomic status. The entire study was conducted in the year 2004–2005.

### *Questionnaire*

A modified Nordic questionnaire<sup>7</sup> was applied which included a number of questions emphasizing individual details, type of work, upper extremity MSD symptoms, affected body parts etc. to investigate the discomfort at work. After explaining the aim of the study in a layman's term, each subject was approached and the questionnaire was performed individually and collected on the spot during the same day. For the symptom survey, the subjects were enquired whether they suffered from tenderness, swelling and warmth in the wrist and from pain, numbness and tingling in the hands.

### *Repetitiveness of work*

A study on repetitiveness was performed through the analysis of time and motion of work in both groups. The total time period for a particular job was recorded by video photography. Different activities constituting that particular job and the time taken for the completion of each activity were recorded with a stopwatch by viewing the video clips. Repetitive activity was considered to be that which occupied more than 50% of the total time period for that particular job. The result will confirm the repetitiveness of the work.

### *Grip strength*

A physical examination was performed by handgrip dynamometer (Make: Rolex, India) to measure the handgrip strength of the experimental group and the comparison group. The handgrip strength was measured following the standard method where in the handle of the dynamometer is adjusted at which the second joint of the index finger is bent at nearly right angles. The body must be straight without side bending; both feet and arms in natural positions and the dynamometer should be gripped with full force<sup>8</sup>. The dynamometer should not come in contact with the body or clothing and should not be swung around. The measurement was done three times (morning, noon and evening) per day among workers at 90° elbow flexion and 180° elbow extension, as it has been observed that the highest and lowest values of grip strength vary in accordance with the elbow positions<sup>9</sup>.

**Table 1. Worker Demographics**

Variables	Experimental Group	Comparison Group	Remarks ( $p < 0.05$ )
	Mean (SD)	Mean (SD)	
Age (yr)	40.4 ( $\pm$ 6.4)	39.3 ( $\pm$ 4.1)	Not Significant
Height (cm)	168.2 ( $\pm$ 11.2)	167.0 ( $\pm$ 9.7)	Not Significant
Weight (kg)	59.9 ( $\pm$ 9.9)	58.2 ( $\pm$ 8.1)	Not Significant
Years of Experience	16.3 ( $\pm$ 8.1)	15.8 ( $\pm$ 7.2)	Not Significant
Duration of work per day (h)	10.5 ( $\pm$ 2.1)	8.0 ( $\pm$ 1.3)	Significant
Duration of rest per day (h)	1.5 ( $\pm$ 1.0)	1.0 ( $\pm$ 0)	–
Number of working days per week	6	6	–

### Statistical analysis

Students *t* test was performed to find out whether there was any significant difference in between the parameters of the groups. A two-tail chi square test of independence was applied to determine whether there is any significant association between the parameters measured. The computed  $\chi^2$  was next compared with the critical  $\chi^2$  value for the chosen level of significance ( $p < 0.05$ )<sup>(10)</sup>.

## Results

The mean values of age, physical parameters (height and weight) and the average years of experience of the subjects in the Experimental group and Comparison group are shown in Table 1. The workers of the experimental group had an average working experience of more than 16 yr, while the other group worked for more than 15 yr.

The daily work schedule including the mean duration of work and rest as well as the number of working days in a week is also represented in Table 1. It was observed that the subjects of both the groups work six days in a week. But the subjects of the experimental group worked  $10.5 \pm 2.1$  h per day and got  $1.5 \pm 1.0$  h of rest per day, whereas the subjects of the comparison group worked  $8 \pm 1.3$  h and got rest for 1 h in a day.

In the experimental group, the repetitiveness of the main activity, i.e., hammering is observed. During a single work cycle of  $90.5 \pm 0.3$  s,  $72.5 \pm 0.4$  s is spent in the main activity (hammering) and the mean frequency of hammering in 72.5 s is found to be 121 times. The total hammering activity is performed for 8.4 h each day. On the other hand the main activities performed by the comparison group is less than 50% of the work cycle. This indicates that the comparison group performs non-repetitive activities in their daily work schedule.

Table 2 shows the association between discomfort and no discomfort among the subjects of the experimental and

comparison groups. Discomfort of upper limb was significantly higher in the experimental group than in the comparison group.

In the Experimental group, 35 (70%) subjects felt discomfort in the hand, 31 (62%) suffered from discomfort in the wrist and 30 (60%) from discomfort in the fingers. The extreme part of the upper extremities that is the hand is found to be an effective zone for the Experimental group. Moreover 20 (40%) workers also suffered from discomfort in the shoulder region.

On the other hand the workers of the comparison group suffered negligibly from such discomfort (Table 3).

Among the workers of the experimental group suffering from discomfort in the hand, 40 (80%) workers felt pain, 20 (40%) of them suffered from tingling and 14 (28%) from numbness in their hands. Furthermore those who suffered from discomfort in the wrist, 30 (60%) workers complained of wrist swelling, 24 (48%) felt warmth and 12 (24%) of them reported of tenderness in the wrist (Table 3).

From Table 4 it is observed that there exists a significance difference in handgrip strength measured at 90° elbow flexion and 180° elbow extension between the subjects of both the groups. The comparison group had significantly higher handgrip strength than the experimental group.

Figure 1 represents the upper limb discomfort feeling of the workers of both the groups. It is observed that out of the 40 workers (80%) of experimental group suffering from discomfort feeling, 48% suffered during work and 32% suffered during rest. Among the 80% workers suffering from discomfort, 20% felt discomfort throughout the day.

## Discussion

The results of this study revealed that the brass metal workers (experimental group) are engaged in rigorous hand intensive jobs for many years, whereas the office bearers

**Table 2. Associations of upper limb discomfort between the experimental group and the comparison group**

Study Groups	Discomfort	No Discomfort	$\chi^2$ Values	Remarks
Experimental Group	40	10	43.7	Significant ( $p < 0.001$ )
Comparison Group	7	43		

**Table 3. Symptoms of upper limb MSD in the experimental group and the comparison group**

Discomfort at the Upper Limb		Study Groups	
		Experimental Group	Comparison Group
Body Parts	Shoulder	20 (40%)	0 (0%)
	Hand	35 (70%)	5 (10%)
	Wrist	31 (62%)	2 (4%)
	Fingers	30 (60%)	0 (0%)
Type of Discomfort Felt in Hand	Pain	40 (80%)	5 (10%)
	Tingling	20 (40%)	0 (0%)
	Numbness	14 (28%)	0 (0%)
Type of Discomfort Felt in Wrist	Swelling	30 (60%)	0 (0%)
	Warmth	24 (48%)	0 (0%)
	Tenderness	12 (24%)	0 (0%)

**Table 4. Relationships between handgrip strength (in kg) of the subjects in the experimental and comparison groups**

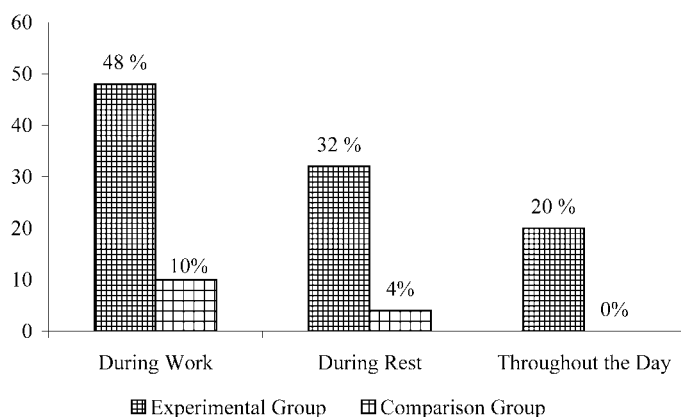
Handgrip Strength		Experimental Group Mean (SD)		Comparison Group Mean (SD)		<i>t</i> value	Remarks
At 90° elbow flexion	Morning	42 (± 2.8)		44 (± 2.8)		4.8	Significant ( $p < 0.001$ )
	Noon	41 (± 3.0)	41 (± 2.9)	43 (± 2.7)	43 (± 3.4)		
	Evening	40 (± 2.4)		42 (± 3.0)			
At 180° elbow extension	Morning	39 (± 3.1)		42 (± 2.4)		8.8	Significant ( $p < 0.001$ )
	Noon	38 (± 2.4)	38 (± 2.1)	41 (± 2.5)	41 (± 2.3)		
	Evening	37 (± 2.8)		40 (± 2.3)			

(comparison group) are not involved in such type of work. There was no significant difference in the physical parameters (height and weight) measured between the groups. Apart from these there was also no significant difference in the other parameters as mentioned in Table 1, except duration of work per day.

According to Silverstein *et al.*<sup>11)</sup> 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 wherein the hammering activity covers 72.5 s, which is 80.1% of the work cycle of 90.5 s. Thus high repetitiveness may be regarded as a causative factor for the

development of MSD in upper limbs.

It is found that all the workers (Experimental group) had some sort of discomfort feeling in the upper limbs of their body as depicted in Fig. 1. The figure also showed that although the workers of the experimental group felt discomfort throughout the day, a greater percentage suffered more during work than during rest. Thus it can be assumed that the job done by the brass metal workers is extremely intense and as a consequence the feeling of discomfort not only prevails during their work but also persists during their rest periods. On the contrary the workers of the comparison group hardly suffered from any such problems. This result



**Fig. 1. Self-reported upper limb discomfort in the experimental group and the comparison group.**

suggests that highly strenuous hand intensive jobs for prolonged period (10.5 h a day) may have lead to the development of musculo skeletal disorders among the brass metal workers as indicated from the reported discomfort feeling.

From the statistical analysis it is evident that there is a significant association between positive and negative responses of discomfort feeling among the experimental and comparison groups. This suggests that the brass metal workers engaged in hand intensive activities have to perform strenuous tasks repeatedly throughout the day, suffered the most, where as the workers of control group performed comparatively less strenuous activity and suffered less.

It is also evident from the results that the subjects of the experimental group suffered from discomfort in the upper extremities, primarily involving the hand (70%), wrist (62%), fingers (60%) and shoulder (40%). As the workers mostly perform the hammering activity below their shoulder level, so the shoulder region may have been least affected. This finding further establishes the fact that the tasks performed by the brass metal workers involve repetitive acceleration of hands with a heavy hammer over sustained period of time.

On the other hand the workers of the comparison group suffered negligibly from such discomfort feeling suggesting that they perform minimum hand intensive jobs.

It has already been reported<sup>5)</sup> that by examining pain, numbness and tingling in the hands and tenderness, swelling and warmth in the wrists, the prevalence of MSD can be detected. A similar result is also obtained in this study wherein most of the brass metal workers (80%) felt pain in the hands, followed by tingling sensation (40%) and numbness (28%) in the hands. These workers also reported of swelling (60%), warmth (48%) and tenderness (24%) in their wrists. Thus

it can be said that many of the workers of the experimental group may be suffering from MSD. But the workers of the comparison group hardly suffer from any of these problems. Therefore it is evident that the office bearers may suffer from MSD affecting different body parts but are less likely to suffer from upper limb MSD.

The handgrip strength of the workers of both groups was measured at 90° elbow flexion and 180° elbow extension. A significant difference in handgrip strength at both positions was observed between the subjects of both the groups. The comparison group had significantly higher handgrip strength than the experimental group. This result corroborates with the work of Alperovitch-Najenson *et al.*<sup>12)</sup> and suggests that the brass metal workers, constantly engaged in hand intensive jobs, are likely to suffer from upper limb MSD. Therefore all the results when aggregated together provide a fairly clear indication of the fact that the brass metal workers are liable to suffer from MSD of the upper limb.

From this study it can be concluded that brass metal workers are constantly engaged in highly repetitive hand intensive jobs and by performing such strenuous jobs for several years, they suffer from discomfort feeling at the upper extremities like the hands, wrists, fingers and shoulder region. The feeling is aggravated with prolonged work, followed by a decrease in the handgrip strength and inability in grasping objects. All these factors consequently may lead to the development of MSD at the upper limbs of the brass metal workers.

With a progressive decline in the number of brass metal workers, there has been a significant shrinkage in the geographical area where these works are practiced. Thus, after considering the situation, the authors were compelled to perform this study among limited number of people. Had

this study been possible a few years back, then the number of workers abandoning the job could have been restricted.

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