



Study and Evaluation of Work related Musculoskeletal Disorder risk in Leather Garments Manufacturing Industry

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Abstract - The aim of this study is to find the level of work related musculoskeletal disorders (WMSD) risk at work and its impact, using Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) in Leather Garments Manufacturing Industry. Musculoskeletal Disorder (MSD) is a common health problem throughout the world and it is a major cause of disability. The economic loss due to such disorders affects not only the individual, but also the organization and society as a whole. The level of Work related Musculoskeletal Disorder (WMSD) risk in a posture and its impact on the workers while maintaining that posture during their work needs to be addressed to find the importance of Ergonomics in the Industries and to create more awareness on WMSD. It is a cross sectional study involving 112 workers from stitching, pasting, cutting and fusing departments of various leather garments manufacturing industries between the age group of 25 to 60 years. Wilcoxon signed ranks test was used to analyze the relationship between Left and Right side in workers using RULA and REBA. This test showed that there was a significant difference between the Left and Right side in both RULA and REBA for Stitchers and Pasters ('p' value was set at 0.05 as level of significance). Scores obtained from the RULA and REBA clearly indicated that, workers are at a high risk of work related musculoskeletal disorders.

Index Terms – Ergonomics, Musculoskeletal Disorder (MSD), Posture, Rapid Entire Body Assessment (REBA), Rapid Upper Limb Assessment (RULA).

I. INTRODUCTION

According to the Work Place Safety and Health Council (WSHC), Occupational disease is defined as any disease contracted as a result of an exposure to the risk factors arising from work activity. The symptom ranges from aches and pains to numbness and limitation of movements in the musculoskeletal system [1]. Musculoskeletal Disorder (MSD) is an umbrella term for various physical injuries and disorders in the musculoskeletal system. MSD can happen suddenly or develop over time. Several factors like awkward posture, repetitive actions, heavy lifting, vibration, fatigue,

working for long hours without rest can lead to Work Related Musculoskeletal Disorders (WMSD). WMSD leads to frequent absenteeism among workers, compensation claims and loss of production to the management [2], [3]. The loss due to such problems not only affects the individual, but also the organization and society as well.

In a developing country like India, Work Related Musculoskeletal Disorders (WMSD) has become a major problem and is widespread in many countries [4]. Several international studies have also shown that there is a high incidence of Musculoskeletal Disorders and work related physical problems in the textile and garment manufacturing industries[5]-[8]. In a private sector in the United States, nearly six million workers experience nonfatal injuries or illness [9]. In Britain, MSDs are believed to represent the largest category of work related illness [10]. WMSDs affect one million people each year and the most common problems are back pain, work related neck and upper limb disorders, repetitive strain injuries and lower limb disorders [11]. These disorders are preventable or at least can be delayed [12]. The risk of WMSDs can increase with an increase in workloads, low work satisfaction, high work demands and work related stress [13]. Therefore immediate attention must be provided to those individuals. Any delay in such cases might result in very lengthy treatment with a long rest period and also results in other sufferings with financial losses to the individual, his / her family, surroundings and the community in turn[14].

The main aim of our study is to minimize injuries that are self-inflicted by workers due to their poor working style in garment industries. Workers in these units work in designing, cutting, fusing, sewing etc. where prevalence of work related musculoskeletal disorders is very high[15]. Therefore an attempt has been made in this study to assess the musculoskeletal disorders on workers performing various tasks in leather garment industry using RULA and REBA tools. Ergonomic

interventions and solutions have been developed on the basis of acquired assessment results.

II. MATERIAL AND METHODS

A. Selection of subject

The cross sectional study was carried out in three leather garments manufacturing industries in Chennai involving 112 workers. Workers between the age group of 25 to 60 and willing to participate were included in the study. Initially, postural assessment was done by a Physiotherapist using plumb line. Workers with structural deformities were excluded from this study. Baseline assessment like age, sex, height, weight and experience was done for all the workers.

Then, the workers were asked to perform their daily routine work in their respective work stations.

A. Rapid Upper Limb Assessment (RULA)

RULA is the survey method developed by Lynn McAtamney and E Nigel Corlett for the use in ergonomic investigations of workplace [16]. It is designed to assess operators who are exposed to musculoskeletal loading which is known to contribute to upper limb disorders. In RULA, human body is divided into two parts. Part A for arm and wrist analysis, while Part B for neck, trunk and leg analysis. A scoring system is assigned at every step, depending on the body position, with the higher scores for more awkward postures. These scores were assigned into four groups for a convenient data analysis (Refer Table I).

Table I. RULA SCORES

Score	Meaning	Group
1 – 2	Acceptable posture	1
3 – 4	Further investigation and change may be needed	2
5 – 6	Further investigation and change soon	3
7	Investigate and implement immediate change	4

B. Rapid Entire Body Assessment (REBA)

REBA was developed by Hignett and McAtamney. In REBA, human body is divided into two parts. Part A for neck, trunk and leg analysis, while Part B for arm and wrist analysis. A scoring system is assigned at every step, depending on the body position, with the higher scores for more awkward postures. Unlike RULA, REBA has an additional feature of assessing the coupling scores. The final REBA scores were assigned into four groups for a convenient data analysis. Score 8 and above are assigned to group 4 (Refer Table II).

Table II. REBA SCORES

Score	Meaning	Group
1	Negligible risk	1
2 – 3	Low risk, change may be needed	2

4 – 7	Medium risk, further investigation and change soon	3
8 – 10	High risk, investigate and implement change	4
11 +	Very high risk, implement change	4

C. Work Posture Assessment

A camera mounted on the tripod was placed on the sagittal (side), posterior (back) and superior (top) view at a distance, which captures the subject full image. Bubble level on the tripod was taken as the reference point for the neutral alignment of the camera. Lumbar (low back) region of the subject was selected as the focus point for both the Sagittal and Posterior view. Head of the subject was selected as the focus point for Superior view. Image was taken in all the three angles, while the subject was performing his / her work. After obtaining the image, it was assessed using RULA and REBA worksheets.

Any instruments held by the subject while performing his / her work was weighed using the weighing machine to get the respective score in RULA and REBA. With the data obtained, final RULA and REBA scores were assessed. RULA and REBA were obtained for both the left and right side of the worker.

III. RESULTS AND DISCUSSION

A. Stitchers

While work in the garment industry is classified as light work, there are considerable static loads placed upon the body and frequent requirements to manually handle large loads. Static loading occurs when fixed postures are adopted, often in awkward positions and the muscles remain contracted for extended periods [17]. It was observed in the stitching department that the operators are engaged in a prolonged forward bent posture while stitching (Refer Figure 1).



Figure 1. Bent posture during stitching

Since back support was not provided, a constant load was maintained in the lumbar region throughout the work. This makes the neck extensor and spinal extensor muscles to get fatigue soon, which in turn leads to neck pain and low back ache. Further the work place lay out

and height of work surfaces forced the operators to adopt awkward or fixed working postures thereby leading to increased amounts of static loading, joint loading or muscle fatigue. As there is residual pain and fatigue, the productivity slowed down. 50% of workers complained of low back pain, 40% of workers complained of left shoulder pain and 10% of workers complained both. In line with our results, the report of World Health Organization says that, 'Of all the occupational risk factors, low back pain constituted 37% and ranks first among the complications caused at work [18]. The results revealed that majority of the workers fall under group 3 and the second majority of workers fall under group 4 in both RULA and REBA, which have high risk. (Refer Table III).

Table III. PERCENTAGE OF WORKERS UNDER EACH GROUP

STITCHERS				
Groups	RULA		REBA	
	Left (%)	Right (%)	Left (%)	Right (%)
1	0	0	0	0
2	2.5	7.5	5	10
3	60	70	67.5	62.5
4	37.5	22.5	27.5	27.5

B. Pasters

It has been observed that pasters are engaged in pasting and hammering the samples for at least 8 hours a day in a standing posture. While standing, the postural muscles work constantly against the gravity to make them stand straight. Any muscle that works continuously without rest immediately leads to fatigue. Since the pasters have to accomplish tasks in standing position, the postural muscles and lower limb muscles get fatigue. Lower limb muscle Soleus, the peripheral heart of the body also becomes weak and more prone for varicose vein.

In addition to this, the hammer used by pasters weighs between 0.30 kg to 0.35 kg. As all the pasters use their right hand to hammer, the right shoulder is raised for convenience and to get more leverage.



Figure 2. Posture study during pasting-Tall worker

Figure 2 shows that workers who were tall tend to lean over the pasting table thereby reducing their load on low back and lower limb which in turn reduces the risk. On the other hand, workers who were short, bend towards their left side with their right shoulder being automatically raised as shown in the Figure 3.



Figure 3. Posture study during pasting-Tall worker

This increases the load acting on the right shoulder. Some of the workers complained of having pain in their neck and right shoulder. In accordance with our report, Hagberg et al [19] reported that muscular pain in the neck and shoulder are more frequent in the worker population.

The mean heights of the table used for cutting is 92cms. Thus, for the short worker a strained posture has to be maintained throughout the day which could have been responsible for pain in the shoulders, neck, upper arm and fore arm. Table IV shows that majority of the Pastors fall under the Group 2 and Group 3 in both RULA and REBA.

Table IV. PERCENTAGE OF WORKERS UNDER EACH GROUP

PASTERS				
Groups	RULA		REBA	
	Left (%)	Right (%)	Left (%)	Right (%)
1	0	0	0	0
2	42.5	30	35	27.5
3	50	60	57.5	57.5
4	7.5	10	7.5	15

C. Cutters

Cutters cut the leather with a knife on an inclined table in standing position. A very small knife is used to cut the leather, which produces muscle strain in the thumb and index finger. Some of the workers used adhesive tape in their fingers as shown in the Figure 4 to get rid of pain and other cut injuries.



Figure 4. Adhesive tape used by workers on their fingers

During cutting, they bend forward and turn slightly to the left. Unlike the pasters, cutters move freely within their workstation. So the chances of muscle to get fatigue in the lower limb are minimal. The actual problem lies in the Line of Gravity (LOG). In the anatomical position, LOG lies anterior to the second sacral vertebrae. During forward bend, the LOG is altered and falls more anteriorly (Refer Figure 5).



Figure 5. Forward bend during cutting operation and LOG

In order to balance it, spinal extensors have to work more. This makes the muscle to get fatigue easily and they are more prone for the low back ache. Table V shows that all the cutters fall under group 4 in RULA and majority of the cutters fall under group 4 in REBA.

Table V. PERCENTAGE OF WORKERS UNDER EACH GROUP

CUTTERS				
Groups	RULA		REBA	
	Left (%)	Right (%)	Left (%)	Right (%)
1	0	0	0	0
2	0	0	0	0
3	0	0	20	13.3
4	100	100	80	86.7

D. Fusers

Interlinings are used to support the outer fabrics so as to create and maintain three dimensional shape and drape

of a garment. Fusers attach the leather pieces to the fusing material by applying heat.

Figure 6 shows the operation which is carried out on the flat table in a standing position for long hours. Further they operate in a small workstation and could not move freely like cutters. They are more likely to get the varicose vein.

Table VI shows that majority of them fall under group 2 in RULA and group 3 in REBA.



Figure 6. Fusing operation done by the workers

Table VI. PERCENTAGE OF WORKERS UNDER EACH GROUP

FUSERS				
Groups	RULA		REBA	
	Left (%)	Right (%)	Left (%)	Right (%)
1	0	0	0	0
2	50	50	0	0
3	33.3	25	75	75
4	16.7	25	25	25

IV. DATA ANALYSIS

Data analysis was done with SPSS software to analyze the influence of the variables like age, height, weight and experience of workers on RULA and REBA. ‘p’ value was set at 0.05 as level of significance for all comparisons. Comparison were made using ANOVA, Mann-Whitney U test and Wilcoxon signed ranks test between the groups, RULA and REBA for the obtained data. The Socio-demographic features of all the workers are given in Table VII.

Table VII. DESCRIPTIVE STATISTICS

Descriptive Statistics					
Variables		Age	Height	Weight	Experience
Stitchers	Mean	40.38	5.395	68.73	18.13
	SD	8.344	0.38958	11.578	9.365
Pasters	Mean	36.32	4.9975	62.4	9.98
	SD	5.916	0.21542	9.599	6.859
Cutters	Mean	38.8	5.6	68.4	18.4

	SD	6.635	0.507	8.846	7.872
Fusers	Mean	35.33	5.05	56	10.83
	SD	6.985	0.29695	10.278	5.589

ANOVA test showed that there is no significance between the Age, Height, Weight and Experience of the selected samples with respect to that of RULA and REBA as the p-value is greater than 0.05. Mann-Whitney U test showed gender has no significance on RULA and REBA.

Wilcoxon signed ranks test is a statistical test of equality of similar or matched groups of data to determine whether they differ significantly from one another, without any assumptions about the underlying distribution patterns. This test showed that there was a significant difference between the Left and Right side in both RULA and REBA for Stitchers (p value 0.005 and 0.015) and Pastors (p value 0.014 and 0.001), while Cutters and Fusers did not have any.

From the data analysis and results, it is clear that the workers working in various departments in Leather Garments Manufacturing Industries maintain an awkward or faulty posture. These awkward or faulty postures are maintained throughout their work duration of 8 hours or more. This leads to the WMSD. Figure 7 shows that majority of the workers fall under the group 3 in both RULA and REBA.

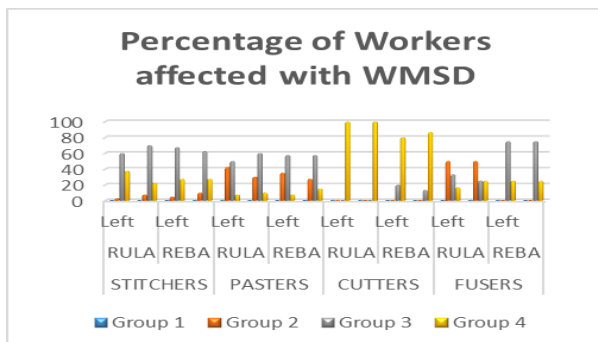


Figure 7. Graphical representation on a comparison between the percentage of stitchers, pasters, cutters and fusers corresponding to the groups.

V. RECOMMENDATIONS

A. Ergonomics

Even though the ventilation and lightening facilities in the garments industry are satisfactory, according to the RULA and REBA scores, it is clear that the workers posture need an ergonomic change and further investigation. Change in posture can be obtained by modifying the workstation.

In stitching department, instead of flat table, an inclined table can be provided with adjustable height. Chair with back support, arm support and adjustable height can be provided. This may in turn reduce the chance of neck pain and low back pain.

With reference to pasting and fusing section, pasting table and a standing chair with adjustable height can be provided to reduce low back pain. Cushion mat / MCR footwear can be used to avoid the risk of heel pain. They are advised to sit at time intervals.

Whereas in cutting, a table with an adjustable height can be provided. Knife with a wooden or plastic holder can be used to minimize the strain in the thumb and index finger. Finger gloves can be used to avoid cut injuries.

B. Exercises

Not only an ergonomic intervention can give a complete remedy, but also it must be accompanied with a set of exercises at regular intervals to workers who work continuously for hours. From a serious analysis of the risk factors of workers in leather garment industries, we were able to identify certain group of muscles which are more prone to get weak soon. They are: Calf, Hamstring, Quadriceps muscles in the lower limb. Shoulder stabilizers, Thenar and Hypothenar muscles in the upper limb. Core stabilizers, Spinal extensors in the pelvic girdle and spine. Eye ball muscles in the head are to name a few. This muscle weakness can be avoided by practicing certain exercises. Ankle pumps, toes exercise, hamstring and quads isometrics for lower limb. Crunches, push-ups and active range of motion exercise to the upper limb. Iron man, spinal extension exercise, cat and camel exercise to the pelvic girdle and spine. 20-20-20 exercise to the eye ball muscles. In the above mentioned, certain exercise can be done in the workstation itself. Stretching the lower limb and upper limb muscles before and after the work is advisable.

VI. CONCLUSION

Scores obtained from the RULA and REBA clearly indicated that, workers are at a high risk of work related musculoskeletal disorders. They need an immediate ergonomic intervention and investigation to avoid more severe illness, which can lead to production loss. An ergonomic intervention accompanied with muscle strengthening exercises and stretching must be taught to the workers to lead a healthy and safe life.

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