Posture Analysis of the Power-Loom Industry Tasks by RULA and NMSQ

Somnath Kolgiri[1] Mayur Jagtap[2] Kondiba Kuber[3] Ganesh Khare[4]
[1]Associate Professor, [2, 3, 4] Assistant Professor, S B Patil COE, Indapur, Pune
[1]sgkolgiri@gmail.com, [2]mayurdjagtap@gmail.com, [3]kuberkondiba@gmail.com, [4]kharegn12@gmail.com

Abstract: The common work-related difficulties of workers are musculoskeletal disorders (MSDs) in India. Currently, work is being done manually in most power loom industries; therefore, work-related musculoskeletal disorders (WMSDs) and injuries at different body sites are of the highest priority. This aim to carry out statistical significance analysis between the scores extracted from RULA using Image or Video analysis and pain data of different body regions using Nordic Musculoskeletal Questionnaire (NMSQ). This ergonomic study sheds light on the analysis 10 of the position of workers in the power loom industry. The study was conducted on workers engaged in the power loom industry located at MIDC Solapur (Maharashtra, India). The RULA technique decided that the majority of employees were in danger and required urgent action. Looking at the correlation coefficients, there isn't much of a difference between using video analysis to evaluate RULA and using NMSQ to locate discomfort in different body regions. Evaluation using the RULA and NMSQ analysis indicates that workers are working above the safe limit. Thus, most of the peoples, functioning with awkward postures, have moderate to high-risk MSDs.

Keywords: Power loom industry, Ergonomic, Awkward postures, MSDs, WMSDs, RULA, NMQS

I. INTRODUCTION

WMSDs are a category of painful muscle, tendon, and nerve disorders that occur from daily arm and hand movements such as arching, stretching, holding, twisting, clamping, and unbending. Such typical movements are not directly hazardous as a consequence of repetitive activities in our everyday lives, but they are dangerous in the workplace because they are continuously repeated, often in a forcible manner with little time for recovery in between. Due to external factors such as production pace, etc., the worker often does not control time and speed of the job, and as a result, the degree of stress can increase [1]. The pressure on muscles increases as the degree of stress increases; causing enervation and increasing the risk of WMSDs. MSDs have a tremendous effect on the workplace. According to Rajgopal et al. (2000), MSDs can affect work tasks and contribute to lower productivity as a result of illnesses, absenteeism, and chronic occupational disorders. The International Labor Organization (ILO) claims that, musculoskeletal injuries account for 40% of all work-related damages and illnesses [2]. The influence of WMSDs was recognized by developing countries. MSDs have been described as a source of pain and misery, as well as a loss of production and growth, in European Union countries, prompting action to reduce these sufferings and losses [3]. According to Chorine et al. (2007), MSDs have become more common due to poor functional states and a lack of useful job trauma inhibition programs. The Nordic Questionnaire of Musculoskeletal Signs was used to examine recorded belongings of MSDs between the sample populations [4]. Hasalkar et al. (2007) looked into the MSDs of farm women who worked with nourishing fertilizer. They discovered that an uncomfortable and standing posture were a risk factor for work-related musculoskeletal problems [5]. Karimfar et al. (2008) researched the musculoskeletal problems of zinc miners in Iran. A

total of 98 staff was interviewed. The NMSQ was used as a data collection method to look at the frequency of MSD. [6]. Pourmahabadian et al. (2008) looked into the dangers of job-related upper-limb MSD in the pharmacy industry. The RULA technique was used to measure the disclosure of hazard elements related to job-related upper extremity discomforts, and the altered NMSQ was used to examine the incidence of WMSD. [7]. Varmazyar et al. (2009) assessed the RULA tool's activity role, muscle use, and effort. The final RULA score ranged from a low of 3 to a high of 7. The final RULA score of 4.87 emphasized poor job station design pointing to hazards among pharmacy packing operators [8]. Ghosh et al. (2010) looked into WMSDs among Indian goldsmiths. They used the RULA technique to study the operating position. Musculoskeletal discomforts were discovered, including neck, low back, wrist, and shoulder pain, as well as itching and burning sensations in the eyes [9]. Tinubu et al. (2010) examined the frequency and activity elements of WMSDs among Nigerian nurses. The examinees were selected from three hospitals in Ibadan. The prevalence rate of WMSDs for a period of 12 months at any body part was 78 percent [10]. Agarwal et al. (2011) investigated the musculoskeletal disorders of workers in a tractor trolley manufacturing plant and used RULA to check their findings [11].

The power-loom industry is one of many industries in India that employ a large number of people in manufacturing activities. Since the workers' behaviors are static and repetitive, they may develop unchanging or forced body postures, continued repetitive movements, and compressed force on the spine, lower back, knee, shoulder, arm, hand, and wrist without enough recovery time. WMSDs are popular among workers in the power-loom industry as a result of a combination of these movements [12]. These industries were noticed to be not using ergonomic standards or interventions to monitor or avoid WMSDs.

II. PURPOSE OF THE STUDY

The purpose of this study were to investigate body positions during operations and perform an ergonomic appraisal of the works task in determining the excessive riskiest group for several body parts intervening with RULA and NMSQ to examine the magnitude of MSDs among the employees from Solapur District, India, of power-loom industries.

III. METHODS AND MATERIAL

This study is carried out at power-loom industry situated at MIDC Solapur (Maharashtra). The 500 workers were selected for study details are given in table 1. The video recording of their ten postures, which depicted the workers' movements while working, was made. After recording the video, it was cropped to acquire snapshots for the purpose of examining the worker's posture. The samples of snapshots were examined to fill the scores in RULA score sheets (appendix I). NMSQ was fundamentally categorized into 3 for the distinct regions if they were with 3 sub-measures. The respondents were told to answer the first sub-measures when they perceived listed musculoskeletal problems sustained for a week. The respondents were told to answer the second sub-measures when they perceived listed musculoskeletal problems sustained for a year. Every subscale questioned for disease indications on 11 distinct body parts: neck, shoulders, elbows, wrists and hands, upper back, low back, Hips/and thighs, legs and knees, ankles and feet. NMSQ can be found in Appendix II.

IV. RESULTS AND DISCUSSION

Typical activity in power-loom industry

Fig 1 shows typical activates in deferent department of power-loom industry. The textile workers wherein perform many tasks, particularly the bales opening, dyeing, carding, spinning and weaving sections, are subjected to more cotton dust resulting in more harmful lung effects.

RULA

According to McAtamney & Corlett, (1993) RULA gives directly measured grades of musculoskeletal burdens on activities while people have an injury of upper extremity and neck burdening Table 2 (obtained from Appendix I) shows the ultimate average score for any activity if above 8 which imply an activity level of 5 that is immediate examination and modifications are needed in the current job station, with ultimate average score for any activity if 7 which imply an activity level of 4 that is urgent examination and modifications are needed in the current job station. For any task, the average score was observed to be 5 which imply an activity level of 3 that is speedy examination and modifications are needed in the current job station [13].

NMSQ

NMSQ is a systematized and scrutiny instrument to determine the body parts attacked by musculoskeletal signs comparatively cheap and simple. There is no requirement of some technical apparatus to carry out this analysis [14]. SPSS software was used to perform analysis over the data collected from participants. Table 3 depicts the NMSQ scores in terms of main for various departments in the power-loom industry. The larger part of the analysis, respondents, that is 58.2% have perceived ache in the lower back while shoulder ache was perceived by 54.2%. Right wrist/hands, upper arm and upper back 18.4, 48.8 and 48.8 % respectively were the second most distressing locations noticed in the examined population. The outcomes of this analysis showed that the power-loom workers occupy in sustained forward flexing body position in their operating circumstance. The analysis showed that 40.34% part of the population on average experiencing minimum one job associated musculoskeletal distress. An identical examination was performed by the Montreuils, Laflames, and Pellier (1996) on textile tufting operators managing thread cone and have stated that 64.9% had one job associated musculoskeletal distress [15].

Recomputed the RULA and NMSQ for 6 Body Regions

Fractions appeared in RULA scores and NMSQ data because say for instance in calculation of RULA score of upper arm of warping, the average of upper arm of RULA scores from the rows of 4, 6 and 7 was taken i.e., (4+4+6)/3=4.67. Similarly in calculation of NMSQ value of trunk of warping, the average of upper back and lower back of NMSQ values from the rows of 1 and 4 (these rows were considered because trunk RULA associated to upper back and lower back, refer Table 4) was taken i.e., (43+50)/2=46.5.

Statistical Analysis

Table 6 shows results of statistical analysis. Student's T and goodness of fit were performed and evaluated Pearson's and Spearman's correlation coefficients to find significance between scores. Following inference was observed from Table 6. By looking the values of correlation coefficients, there is no big difference to perform video analysis for evaluation of RULA and administer Nordic Musculoskeletal Questionnaire for finding pain in body regions. The regression equations were also found out to find NMSQ value from RULA scores.

V. CONCLUSION

The RULA and NMQS methods were used to evaluate body posture in the power-loom industry, and it was found that a large proportion of the workers are employed in uncomfortable and painful postures. Evaluation using the RULA and NMSQ analysis indicates that workers are working above the safe limit. Thus, most of the workers, working with awkward postures, have moderate to high-risk MSDs. By looking the values of correlation coefficients, there is no big difference to perform video analysis for

evaluation of RULA or administer NMQS for finding pain in body regions. This study recommends that ergonomics interventions be implemented immediately, with worker receiving proper training and health education on common postural changes, as well as industry-wide monitoring of laws to reduce morbidity from musculoskeletal disorders.

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Table 1: Anthropometry and job association of workers in power loom industry

Dept/ Anthropometry and job details		Bleach-ing	Dye-ing	Warp-ing	Spinn-ing	Power Weav-ing	Finish-ing
M/F Ratio		9:1	9:1	8:2	2:8	10:0	2:8
Age		31.81± 3.83	30.25± 1.65	30.46 ± 3.72	32.24 ±4.03	30.81 ± 2.94	26.51 ± 2.09
Height	Male	166.52 ±2.47	167.48 ±2.89	167.65 ±3.75	168.44 ±2.78	166.23 ±2.6	166.25 ±3.43
	Female	155.45 ±2.42	152.53 ±2.36	154.26 ±3.51	152.26 ±2.69	-	153.61 ±2.54
Weight	Male	61.9 ±3.01	60.8 ±2.98	62.8 ±4.33	61.5 ±4.56	61.2 ±4.43	63.2 ±2.74
	Female	50.7 ±2.85	51.5 ±2.64	50.1 ±3.53	52.2 ±5.48	-	50.6 ±2.41
Average Experience		11.6 ±4.2	10.8 ±6.4	11.2 ±3.2	11.4 ±2.4	10.8 ±4.2	8.2 ±4.8
Working Hours		10.0±2.8					

Table 2: RULA Scores of various tasks performed by workers in power loom industry

Sl No	Dept/Body Parts	Upper Arm	Lower Arm	Wrist	Wrist Twist	Wrist/ Arm Posture	Wrist/ Arm Muscle	Neck	Trunk	Leg	Trunk Posture	Trunk Muscle	Trunk Load
1	Dyeing	5	2	4	1	7	0	2	5	2	7	1	1
2	Guiding in Spinning	5	1	4	1	5	0	4	4	2	7	0	0
3	Loading in Spinning	3	3	4	1	7	0	2	3	2	5	1	0
4	Guiding in Warping	4	2	4	1	5	1	3	4	2	6	0	0
5	Power Weaving	4	2	4	1	5	0	3	2	2	4	0	0
6	Warping from spool	4	3	3	1	5	1	3	2	2	4	0	0
7	Warping Thread	6	3	3	1	9	1	3	3	2	5	0	0
8	Beam Threading	4	3	3	1	5	1	3	4	2	6	1	0
9	Removal	3	3	3	1	4	1	3	4	2	5	1	0
10	Sewing	3	2	3	1	4	1	3	4	2	6	1	0
	RULA Total Score	**41**	**24**	**35**	**10**	**56**	**6**	**29**	**35**	**20**	**55**	**5**	**1**

Note: -RULA score from, Appendix I

Table 3: Scores are obtained directly from power loom workers using Nordic Musculoskeletal Questionnaire (NMSQ): N is Population Size

Sl.No	Pain/Departments	Bleaching/ Dyeing N=100	Warping N=100	Spinning N=100	Power Weaving N=100	Finishing N=100	% Score
1	Lower Back	66	43	67	57	58	58.2
2	Shoulder	56	64	64	47	40	54.2
3	Upper Arm	52	56	56	45	35	48.8
4	Upper Back	38	50	50	51	39	48.8
5	Knee	47	39	25	40	45	45.6
6	Thigh	19	11	8	19	29	39.2
7	Ankle	14	13	23	14	28	17.2
8	Wrist	45	42	52	28	33	18.4
9	Neck	25	52	42	43	35	40
10	Elbow	28	44	21	46	31	39.4
11	Fingers	9	15	17	9	27	34

Note: -NMSQ score from, Appendix II

Table 4: Obtained chart for comparing factors between RULA Wizard and NMSQ

	RULA	NMSQ
1	Upper Arm	Shoulder + Upper Arm
2	Wrist+ Wrist Twist	Wrist
3	Trunk	Upper Back+ Lower Back
4	Neck	Neck
5	Lower Arm	Elbow
6	Leg	Thigh + Knee + Ankle

Table 5: Using Table 4 recomputed the RULA and NMSQ for 6 Body Regions.

Depts/Body Parts	Bleachin/Dyeing		Warping		Spinning		Weaving		Finishing-Sewing	
	RULA	NMSQ	RULA	NMSQ	RULA	NMSQ	RULA	NMSQ	RULA	NMSQ
Upper Arm	5	54	4.67	60	4	60	3.67	46	3	37.5
Wrist/Wrist Twist	2.5	45	2.17	42	2.5	52	2.17	28	2	33
Trunk	5	52	2.5	46.5	3.5	58.5	3.33	54	4	48.5
Neck	2	25	3	52	3	42	3	43	3	35
Lower Arm	2	28	2.67	44	2	21	2.67	46	2	31
Leg	2	26.67	2	21	2	18.67	2	24.33	2	34

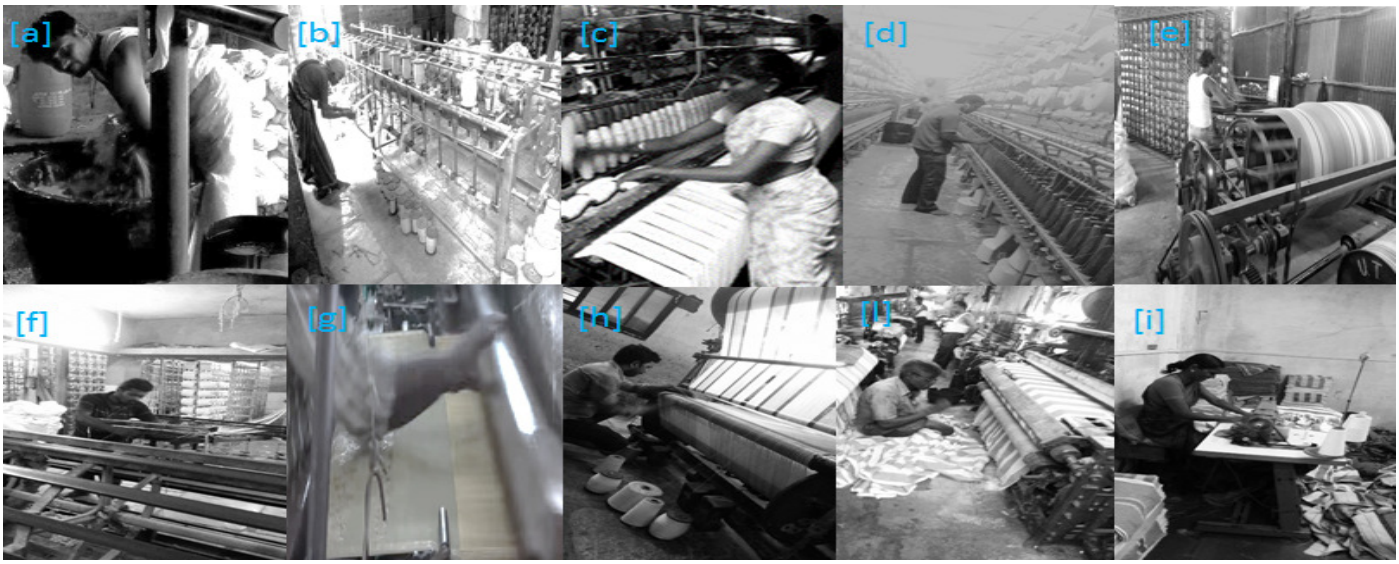
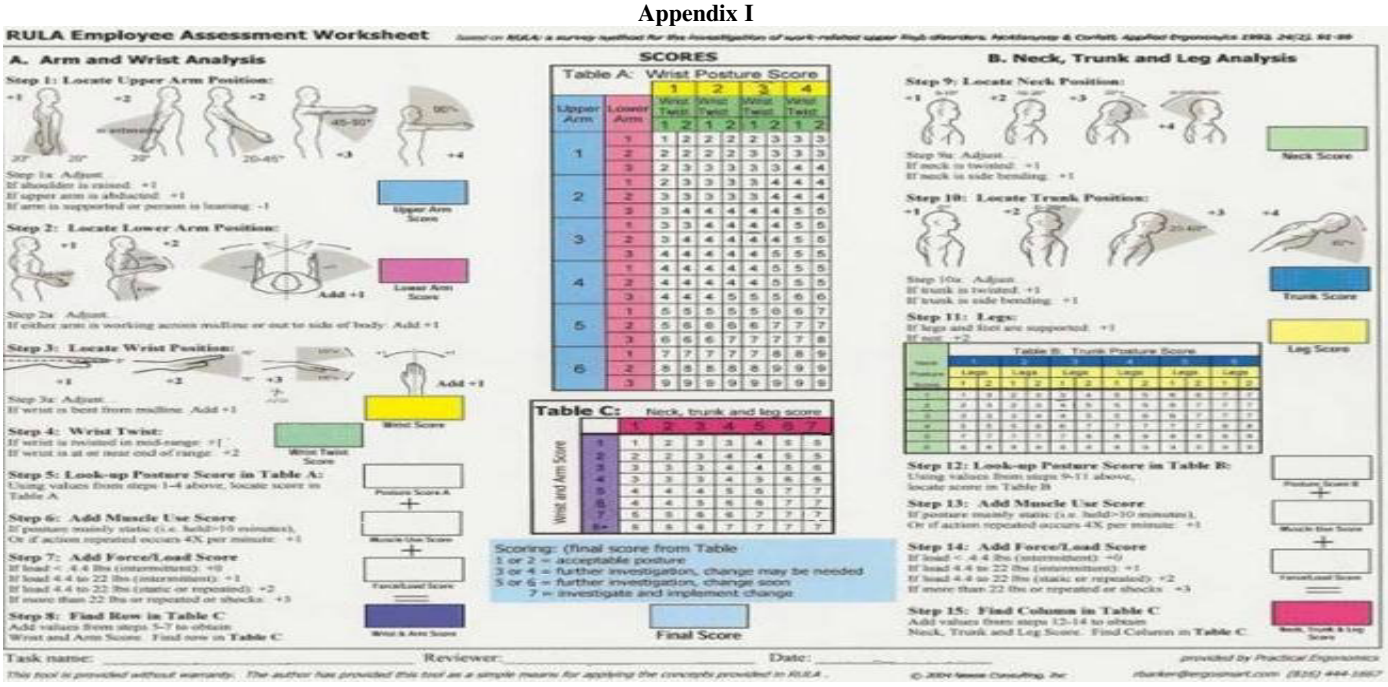


Figure 1: Postures and movements display by workers during work

Table 6: Significance relation between RULA analyzed from images and NMSQ obtained from Workers

Methods	Parameter	Bleach/Dyeing	Warping	Spinning	Weaving	Finishing
Pearson's	Coefficient	0.9036	0.7952	0.8763	0.8637	0.9194
	P Value	0.00675	0.0293	0.0110	0.013	0.00474
Spearman's	Rho	0.92582	0.94286	0.92763	0.811679	0.92582
	P -2 tailed	0.00805	0.0048	0.00767	0.04986	0.00805
Student's T	T value	-6.42625	-7.71925	-5.23008	-7.92671	-13.12549
	P value	0.000038	<0.00001	0.000192	<0.00001	<0.00001
Regression	Equation	8.084+13.52R	13.69+10.78R	19.68R-13.74	15.27R-2.638	7.050R+17.70
Goodness of Fit	R-Square	0.8164	0.6323	0.7680	0.7460	0.8453
	S_{y-x}	6.417	8.886	9.877	6.504	2.753

Appendix I



Source : McAtamney, L. & Corlett, E.N. (1993)

II

Musculoskeletal Discomfort Form (Based on the Nordic Questionnaire (Kourinka et al. 1987))

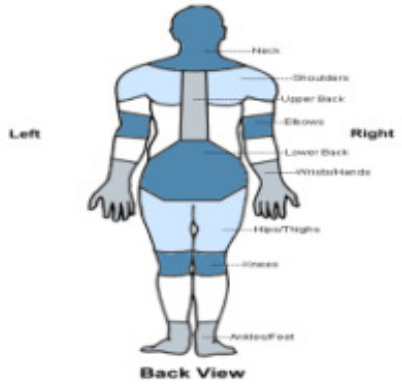
Employee ID:_____

Job/Position: _____ Gender: M F Age: _____ Height: _____ ft._____ in. Weight: _____

How long have you been doing this job? ____years ____ months How many hours do you work each week? _____

How to answer the questionnaire:

Picture: In this picture you can see the approximate position of the parts of the body referred to in the table. Limits are not sharply defined, and certain parts overlap. You should decide for yourself in which part you have or have had your trouble (if any).



Back View

Table: Please answer by putting an "X" in the appropriate box - one "X" for each question. You may be in doubt as to how to answer, but please do your best anyway. Note that column 1 of the questionnaire is to be answered even if you have never had trouble in any part of your body; columns 2 and 3 are to be answered if you answered yes in column 1.

To be answered by everyone		**To be answered by those who have had trouble**			
Have you at any time during **the last 12 months** had trouble (ache, pain, discomfort, numbness) in:		Have you at any time during the **last 12 months been prevented from doing your normal work** (at home or away from home) because of the trouble?		Have you had trouble at any time during **the last 7 days?**	
Neck ☐ No	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes
Shoulders ☐ No	☐ Yes, right shoulder ☐ Yes, left shoulder ☐ Yes, both shoulders	☐ No	☐ Yes	☐ No	☐ Yes
Elbows ☐ No	☐ Yes, right elbow ☐ Yes, left elbow ☐ Yes, both elbows	☐ No	☐ Yes	☐ No	☐ Yes
Wrists/Hands ☐ No	☐ Yes, right wrist/hand ☐ Yes, left wrist/hand ☐ Yes, both wrists/hands	☐ No	☐ Yes	☐ No	☐ Yes
Upper Back ☐ No	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes
Lower Back (small of back) ☐ No	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes
One or Both Hips/Thighs ☐ No	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes
One or Both Knees ☐ No	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes
One or Both Ankles/Feet ☐ No	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes

Source : Kuorinka I. & Jonsson B. (1987)