

Ergonomic Assessment in Motor Assembly Line

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Abstract - Improper ergonomics can cause Work Related Musculoskeletal Disorders (WRMSDs) or Workplace Musculoskeletal Disorders (WMSDs). This includes manual lifting, loading, unloading, pushing, pulling, holding and other risk factors such as repetition, force, awkward and static postures. The current ergonomics assessment was evaluated on workers working in a submersible motor assembly line. To identify the frequency, severity and interference using the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). At the same time to identify workers MSD risk exposure level using a Rapid Upper Limb Assessment (RULA). The data was to be collected by CMDQ and RULA for the same persons in 8 different tasks for 10 workers. Compared the CMDQ and RULA results. Finally suggest the control measures to improving the working conditions in the motor assembly line.

Key Words: Assembly line, Ergonomics, WRMSD, CMDQ and RULA, Risk factors

1. INTRODUCTION

Ergonomics is a branch of science that study about human physical and psychological capabilities and limitations. Purpose of ergonomics is to fit between work and worker. It involves design or modifies the workplace, products, equipment or work practices. Ergonomics sources are the work itself, tools characteristics and work environment [1]. Musculoskeletal Disorders or MSDs are ergonomic disabilities/ injuries. It affect the movement of the human body or the musculoskeletal systems such as muscles, tendons, ligaments, nerves, joints, blood vessels and spinal discs [2].

Musculoskeletal Disorders are the most common work related injuries/ disabilities problem in any manufacturing industry, especially in manual assembly line. Forceful exertions, awkward posture, pulling, lifting and prolonged standing in the manual assembly line can increase the MSD risk level. MSD can be reducing by proper design of workplaces, implementing the job rotation and use of mechanical material handling equipment. Proper ergonomics principles can improve productivity, comfort to the workers and reduce work- related disorders [3].

MSD will reduce the economic level, standards of living, productivity and also employee wages. MSDs are classified into different categories based on the body's pain location and most of the work related MSDs are includes turning, pulling, pushing, reaching, rising and also prolonged standing can caused due to overtime, work itself or work environment. At work, workers perform many tasks that can cause MSDs, such as pain, discomfort, and fatigue [4]. In manufacturing of assembly line involves repetitive work movements that cause neck and arm pain. The repetitive movement cause both discomfort and pain in leg [5].

A study of the mould manufacturing process revealed that workers were at risk for upper limb disorders. Repetitive tasks, awkward posture and prolonged period of working cause upper limb disorders risk. The upper limbs such as neck, shoulder, wrist and arms involves repetitive movements during working period in manufacturing industry [6]. Assembly of engineering, automobile and electrical industries the workers were affected number of MSDs including repetitive strain injuries and also spinal disease it will affect quality of life [7].

Low back pain is the one common WMSD and the factors include excessive load, bending, twisting, manual material handling and vibration of whole body to create WMSD. Lifting also increased low back pain due to low back muscle fatigue [8].

Manual material handling causes frequently MSDs such as lower back pain. MSDs are also called as Cumulative Trauma Disorders (CTDs), Repetitive Strain Injuries (RSIs) and Repetitive Trauma Injuries (RTIs). Tendon disorders, neurovascular disorders and nerve entrapment disorders are associated with upper limb MSDs or CTDs [9].

2. OBJECTIVES

The present objective of the study is to investigate discomfort frequency, discomfort severity and interference of workers working in motor assembly line through CMDQ and also investigate MSD risk level through RULA method.

3. MATERIALS AND METHODS

3.1 Participant and task description of study

This study was conducted in motor manufacturing industry the workers working in the motor assembly line located in Coimbatore. The 80 full time workers was participated in this study of different 8 assembly task with age group of 21- 25. The assembly of top house assembly in submersible motor consists loading, cable fixing, top bear housing fitting, top bear housing pressing, rubber fixing, cable box fitting, cable box mounting (manual tightening) and unloading.

3.2 Cornell Musculoskeletal Discomfort Questionnaire (CMDQ)

The CMDQ was used to assessing the discomfort frequency, severity and interference with the working ability. It was initiated by Dr. Alan Hedge and ergonomics students of Cornell University. They developed well data collection tool and named it CMDQ [10].

This CMDQ features 20 different body parts for assessing the discomfort frequency, severity and interference in the last 7 days. The discomfort score were calculated based on the CMDQ score instruction for identifying the discomfort levels. During the survey a value was assigned to the frequency of the discomfort level as: never- 1, 1-2 times last week- 2, 3-4 times last week- 3, once every day- 4, several times every day- 5. Discomfort severity level score or rating was assigned a value as: slightly uncomfortable- 1, moderately uncomfortable- 2, very uncomfortable- 3 and interference with ability to work rating was not at all- 1, slightly interfered- 2, substantially interfered- 3 [10, 11]. The total discomfort score was calculated using this formula:

Total discomfort score: frequency² × severity² × interference [5, 12]

3.3 Rapid Upper Limb Assessment (RULA)

RULA (Rapid Upper Limb Assessment) was created in 1993 by Dr. Lynn McAtamney and Dr Nigel Corlett from the University of Nottingham, UK.

This is the most widely used method because of its methodology is easy to assessing the risk level involved in the upper extremities such as arms, hands, neck, shoulders and back [13]. A single work sheet used to evaluate the MSD risk level. This methodology gives a detailed evaluation (angle wise) of each body parts, there are widely divided into two groups, group A (upper and lower arms, wrist, wrist twist) and group B (trunk, neck and legs), use of muscle (static/ repetitive), force/ load (static/ intermittent/ repetitive) [13, 14, 15].

4. RESULTS AND DISCUSSION

4.1 Cornell Musculoskeletal Discomfort Questionnaire (CMDQ)

In the above mentioned 8 different tasks, the highest discomfort level was shown in loading task and next to that, cable box mounting task shown discomfort level, then unloading task and finally top bear housing fitting shown discomfort level as shown in the Fig- 1.

In loading task high discomfort score was lower back, shoulder, wrist, neck and knee because while they loading the motor workers are fully bended. In cable box mounting task high discomfort score was right wrist, right shoulder, lower back, right knee because while they cable box mounting excessive force to give tightening. In unloading task high discomfort score was right shoulder, lower back, right knee, right forearm and right wrist. In top bear housing fitting task high discomfort task was lower back, right wrist, right wrist and right forearm.

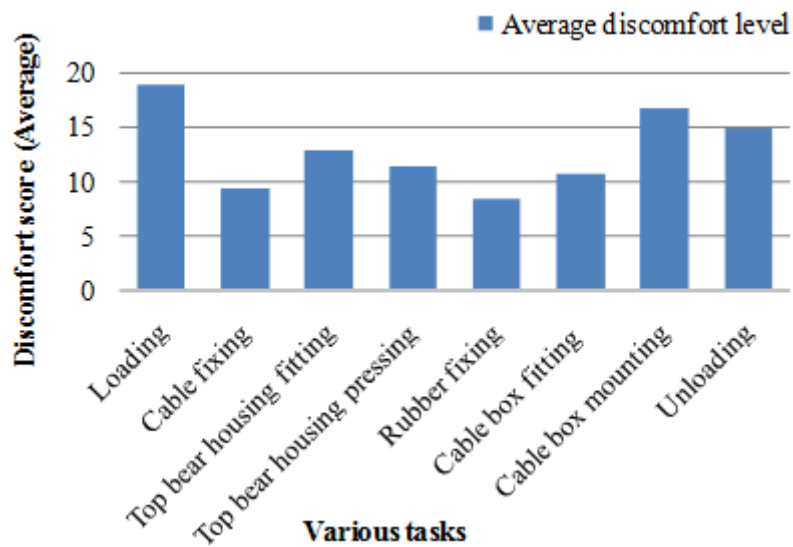


Figure 1 Average discomfort level for various tasks

4.2 Rapid Upper Limb Assessment (RULA)

Similarly, in the above mentioned 8 different tasks, the highest MSD risk level was shown in loading task and next to that, cable box mounting task shown MSD risk level, then unloading task and finally top bear housing fitting shown MSD risk level as shown in the Fig- 2. In loading task trunk was in awkward posture because of poor workplace. In cable box mounting wrist twist, twist was not acceptable posture because not proper tool for this task. In unloading task lower back, wrist and fore arm was unacceptable posture because not proper design of work station. In top bear housing knee, lower back was not acceptable posture because not suitable tool for this task.

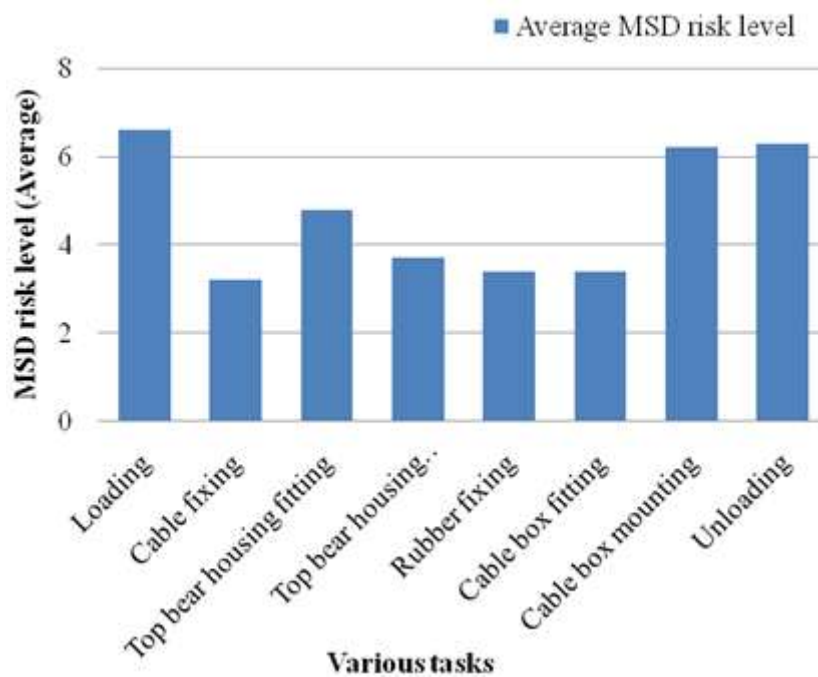


Figure 2 Average MSD risk level for various tasks

4.3 Comparison of CMDQ score and RULA score

Fig- 3 shows the comparison of CMDQ average and RULA average score of various tasks such as loading, cable fixing, top bear housing fitting, top bear housing pressing, rubber fixing, cable box fitting, cable box mounting and unloading. In this comparison of CMDQ and RULA the loading, cable box mounting, unloading and top bear housing fitting was high level score.

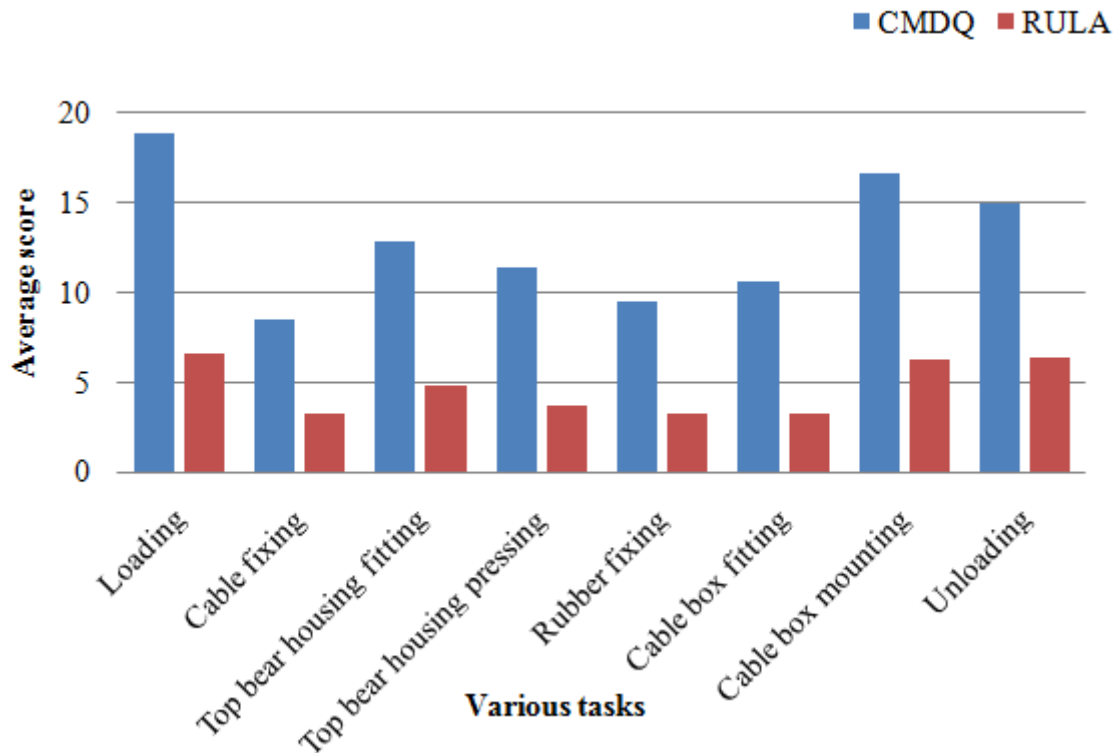


Fig- 3: Comparison of CMDQ score and RULA score

5. RECOMMENDATION

1. In loading process we can provide a stand for bin can be reduced bending
2. In cable box mounting process provide a pneumatic gun for tightening the bolts so that wrist movements and excessive force can be reduced and tightening time also decreased
3. In unloading process we can provide adjustable stand so avoid awkward posture and also provide adjustable trolley for different size of motor so we can avoid trunk, neck bend and also excessive wrist bend
4. In top bear housing fitting process we can provide fixed tool in attached with machine to reduce excessive amount of force while fitting cap

6. CONCLUSION

The data was collected by CMDQ for discomfort frequency, severity, interference and MSD risk was identified RULA tool. In loading, cable box mounting and unloading processes are identified very high risk level (change soon) in RULA and also high discomfort frequency, severity, interference in CMDQ. The CMDQ discomfort level was reported by the workers in different body parts such as neck, forearm, shoulder, knee, lower back, wrist, upper arm and highest discomfort level was lower back, shoulder and wrist. The RULA shows position of trunk, wrist, neck and arm are not acceptable when working of workers due to unaware of ergonomics, improper workstation design, improper material handling and excessive force.

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