Biomechanical risk factors among the assembly line workers of a cosmetics manufacturing factory in India

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Abstract. The aim of this study was to find out the perceived exertion and postural risk factors among a group of assembly line workers in a cosmetics manufacturing company in India. Initially there was a general task inspection by floor visit by a team of ergonomists to identify tasks that might be considered to predispose workers to Work related musculoskeletal disorder (WRMSD). Nine tasks were identified to be problem tasks among 38 task areas visited and a detailed ergonomic workplace analysis of those tasks was performed. Photographs and video recording of the chosen tasks were taken. Rapid Upper Limb Assessment (RULA) was used to evaluate the posture and Rate of Perceived Exertion (RPE) by Moore and Garg Strain Index. Among all the tasks shampoo bottle packing line (n=2), shampoo bottle packing area (n=6), container filling (n=10), sachet sorting (n=2), assembly of bottles (n=4), manual filling line (n=2), manual capping of bottles (n=4) and chemical feeding process (n=2) were found to be high risk tasks. Among 9 different tasks in 5 different lines, 3 were assessed with REBA and other 6 were assessed with RULA to find out possible postural hazards. Among the parameters, duration of exertion was high for 6 tasks, efforts per minute were higher for 7 tasks and speed of work was more for 5 tasks. Hand and wrist posture and intensity of exertion found to be at risk in 3 tasks respectively.

Keywords. Biomechanical risk, Cosmetics, Assembly line, Postural risk.

1. Introduction

Work related musculoskeletal disorder (WRMSD is an area of concern worldwide, with the rapid growth of industries in the present decade. A high incidence of WRMSD has been reported in industrially developing countries like India (Shahnavaz H., 1987). WRMSD are mostly cumulative resulting from repeated exposure to loads at work over a certain period of time. Employees working in manufacturing and transport, plant and machine, operators and assemblers, construction and mining are those who are higher risk of developing WRMSD as compared to employees working elsewhere (Shikdar AA et al., 2003) Among them, assembly line work is considered to be at risk for WRMSD. The biomechanical risks related to assembly line work can be assessed through a qualitative Ergonomic Workplace Analysis (EWA) of the workers.

2. Methodology

A prospective EWA was conducted in a cosmetics manufacturing factory by a team of ergonomists. The study was focused and designed to identify the possible biomechanical risk factors that might predispose workers in semi-automated assembly lines of a cosmetic

factory to WRMSD. Initially there was a floor by floor visit by a group of ergonomists to identify tasks that might be considered to predispose the workers for WRMSD. Nine tasks were identified to be problem tasks among 38 task areas visited based on the observation and discussion of the ergonomists. A detailed EWA of those nine tasks was performed. Workstation information consisted of duration of work, intensity of work, efforts per minute, break, working postures, working surface, weight of the object, force excretion, etc. Photographs and video recording of the tasks where taken for further evaluation (Wilson JR et al., 1992) All the photographs and videos were taken bilaterally and with the viewing angle aligned properly to eliminate any possible Visual Parallax. Rapid Upper Limb Assessment (McAtamney L et al., 1993) and Rapid Entire Body Assessment (Hignett S et al., 2003) were used to evaluate the postural risk screening and Moore-Garg Strain Index (SI) was used to determine any risk of developing musculoskeletal disorders of the distal upper extremity (Moore JS et al., 1995). Based on the risk level, appropriate recommendation and modification were given for each of the tasks.

3. Results

The nine tasks which were found to be of high risk were shampoo bottle packing line (n=2), shampoo bottle packing area (n=6), container filling (n=10), sachet sorting (n=2), assembly of bottles (n=4), manual filling line (n=2), manual capping of bottles (n=4), packed box handling (n=4) and chemical feeding process (n=2). Among the 9 different tasks in 5 different lines, 6 tasks were assessed with RULA, 3 tasks were assessed with REBA and 8 tasks were assessed with Moore-Garg SI based on the risk factor pertaining to each of the tasks. Task description of the nine tasks along with the subjective assessments and the risk factor assessment tool used are mentioned in Table 1.

Table 1: Initial Ergonomic Evaluation of the high risk tasks in the Cosmetic factory

TASK	TASK DESCRIPTION	SUBJECTIVE ASSESSMENT	ASSESSMENT TOOL
1	Pasting literature on the product bottles in the conveyer belt	Both hands (L:R = 1:1) Standing Shift duration: 4hr Speed of conveyer belt not controlled by worker Weight is negligible Micro breaks Not known	SI REBA
2	Packing Line. Taking the finished box packed products from the conveyer, putting them into a bigger box and pushing it forward for further sealing and labeling.	Both hands (L:R = 3:2) Standing Shift duration: 4hr Every 15 s the work cycle is repeated Weight < 2 kg Reach out and bend forward 30 to 40 deg	SI RULA
3	Taking the packed bottles from the conveyer belt and putting it on the boxes then packing the box, labeling and putting it	Both Hands (L:R = 4:3) Standing Shift duration: 4hr Weight 150g Sometimes have to take rejected bottles from the ground	SI REBA

	aside.		
4	Filling line. Taking the empty bottle with the left hand, holding it under the filling machine for approximately 4 to 5 sec and then placing the filled bottle on a table approximately 12 inches with the right hand.	Both Hands (L:R = 1:1) Sitting Weight 100g Shift duration: 4hr Flow of the filling machine is continuous Has to abduct his arms while taking and keeping the bottles	SI RULA
5	Taking the sachets of shampoo from the conveyer belt, folding them together and putting them aside using both hands	Both hands (L:R = 1:1) Sitting Weight 300g Shift duration: 4hr Speed of conveyer belt is constant and worker cannot control Sits in a chair not close to the table Shoulder remains elevated during work	SI RULA
6	Taking the empty bottle from container and putting them into the slots of automated conveyer chain with both hands.	Both hands (L:R = 1:1) Standing Weight 30g Shift duration: 4hr Speed of conveyer belt is not controlled by the worker Raise arm, grab bottle, push in	SI RULA
7	Packing line. The worker has to hold the bottle with the left hand and with right hand hit the cap of the bottle with the help of the plastic hammer.	Both hands (L:R 1:1) Standing Weight >1kg Task duration: 4hr Hold bottle, hit the hammer, place on conveyer. Sometimes fwd bending while placing the bottle.	SI RULA
8	Packing line. Taking the packed and labeled bottles of products from the conveyer belt and putting them in a carton placed over a table.	Both hands (L:R 1:2) Standing Work place is congested and restricting free movements Table ht: 31inch box ht. 14 inch	SI RULA
9	Taking a sac of chemical powder, lifting and carrying up to the feeder and emptying on the vessel.	Both hands (L:R 1:1) Lifting and carrying Weight 25 – 35 kg Shift duration: 3hr Raise the sac, carry and pour it in a container.	REBA

The RULA scores of the tasks 2, 4, 5, 6, 7 and 8 were calculated for the six tasks that was assessed for upper extremity risk levels and described in Table 2.

Table 2: RULA Outcome scores with Action levels

TASK	RULA SCORE	ACTION LEVEL	ACTION CATEGORY
2	3	2	Further Investigation needed; Changes may be required
4	6	4	Investigation and Changes are required immediately
5	7	4	Investigation and Changes are required immediately
6	5	3	Investigation and Changes are required soon
7	4	2	Further Investigation needed; Changes may be required
8	5	3	Investigation and Changes are required soon

The REBA scores of the three tasks: 1, 3 and 9 were assessed for postural risk factors and the values obtained for left and right side were 3:3, 5:3 and 9:8 respectively. The REBA scores and risk level are described in Table 3.

Table 3: REBA Scores with the risk level

TASK	REBA SCORE		REBA SCORE RANGE		REBA RISK LEVEL	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
1	3	3	2 to 3	2 to3	Low	Low
3	5	3	4 to 7	2 to 3	Medium	Low
9	9	8	8 to 10	8 to 10	High	High

The SI score for the measurement of exertion, efforts per minute, hand or wrist posture and speed of work were calculated and the eight tasks (except task 9) that were calculated are described in Figure 1.

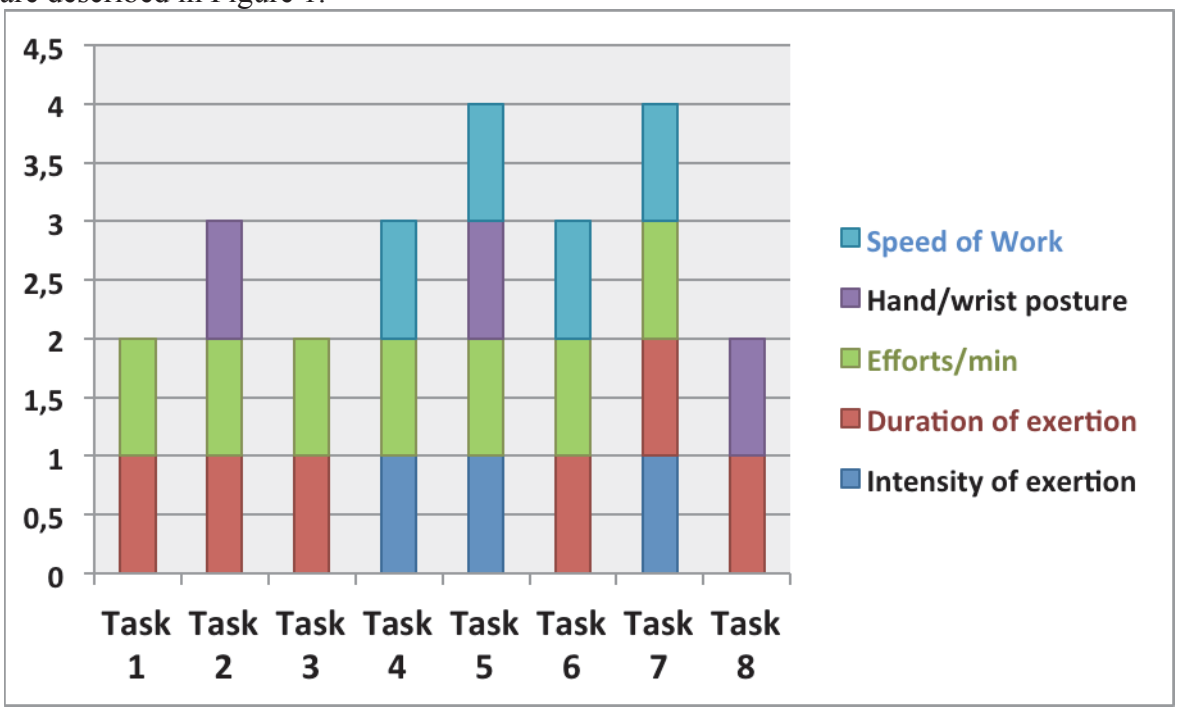

Figure 1: Moore–Garg Strain Index value for the high risk tasks

4. Discussion and Conclusion

This study reported the presence of postural and distal upper extremity postural risk factors for the assembly line workers in the evaluated cosmetic industry. This study enumerated the various biomechanical risk factors that might predispose workers in semi-automated assembly lines of a cosmetic factory to WRMSD. This will help in focusing attention towards preventive strategies including job design.

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