Ergonomic and Postural 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. A prospective study of ergonomic workplace analysis in a cosmetics manufacturing factory was conducted. Initially there was a floor by floor visit by the experts to identify tasks that might be considered to predispose workers to MSD. Nine tasks were identified to be problem tasks among 38 task area visited and a detailed workplace assessment of those nine tasks was performed. Work-station 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. Rapid Upper Limb Assessment and Strain Index were used to identify risk. 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. Final RULA scores for all these six tasks were 3, 6, 7, 5, 4, 5 respectively, whereas REBA scores of other 3 tasks were 3-3, 5-3, 9-8 (Right-Left) which suggested the presence of moderate to severe postural risks. Moor and Garg Strain index was used for 8 tasks to measure the rate of exertion. Among the parameters, Duration of exertion was high in 6 tasks, efforts per minute was higher in 7 tasks and speed of work was more in 5 tasks, whereas Hand and wrist posture and Intensity of exertion found to be at risk in 3 tasks respectively.

INTRODUCTION

Work related disorder is an area of concern worldwide, with the rapid growth of industries in the present decade. It is distributed in developed countries as well as developing countries, with incidence of high levels especially in the industrially developing countries like India[1]. 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 experience more WRMSD as compared to employees working elsewhere[2]. Among them, assembly line work is mostly present in all the industries and employees working in them are more prone to get WRMSD, because of the work nature of assembly line.

Assembly lines are designed for the sequential organization of workers, machines or parts. All parts of assembly lines are handled by conveyors or motorized vehicles. The principles of assembly line as described by Henry Ford are as follows: 1. Place the tools and the men in the sequence of the operation so that each component part shall travel the least possible distance while in the process of finishing; 2. Use work slides or carrier so that when a workman completes his operation, he drops the part always in the same place and if possible have gravity carry the part to the next workman for his operation; 3. Use sliding assembling lines by which the parts to be assembled are delivered at convenient distances. The primary motive for the inclusion of assembly line system in the industries is to reduce the worker stress by avoiding lifting of weights, bending and easy operation[3, 4]. However, the lack of proper knowledge of assembly line working and workplace arrangement leads to increased risk of WRMSD among the assembly line workers.

Knowledge and information regarding this can be obtained through a qualitative Ergonomic Workplace Analysis (EWA) of the assembly line workers. One of our EWA done for the assembly line workers of a Cosmetic industry is described in this paper.

METHODOLOGY

A prospective study of ergonomic workplace analysis in a cosmetics manufacturing factory was conducted. The study was focused and designed to understand and identify the possible ergonomic risk factors that might predispose to WRMSD among a group of workers in semi-automated assembly lines of a cosmetic factory. The study was approved by the Institutional Review Board and the participant consent of the subjects was also obtained. Initially there was a floor by floor visit by the experts to identify tasks that might be considered to predispose the workers for MSD. Nine tasks were identified to be problem tasks among 38 task areas visited and a detailed workplace assessment of those nine tasks was performed. Work-station information consisted of duration of work, intensity of work, speed 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[5]. 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 (RULA) and Rapid Entire Body Assessment (REBA) were used to evaluate the postural risk screening and Moore - Garg Strain Index was used to determine any risk of developing musculoskeletal disorders of the distal upper extremity (DUE) [6, 7, 8]. Based on the risk level, appropriate recommendation and modification were given for each of the tasks.

RESULTS

The nine Tasks which were found to be of high risk are 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 has been assessed with RULA, 3 tasks has been assessed with REBA and 8 tasks has been assessed with Garg SI based on the risk factor pertained 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	1. Both hands (L:R = 1:1) 2. Standing 3. Shift Duration: 4hr 4. Speed of conveyer belt not controlled by worker 5. Weight is negligible 6. Micro breaks Not known	1. Moore-garg strain index (SI) 2. Rapid Entire Body Assessment (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.	1. Both hands (L:R = 3:2) 2. Standing 3. Shift Duration: 4hr 4. Every 15 s the work cycle is repeated 5. Weight < 2 kg 6. Reach out and bend forward 30 to 40 deg	1. Moore-garg strain index (SI) 2. Rapid Upper Limb Assessment (RULA)
3	Taking the packed bottles from the conveyer belt and putting it on the boxes then packing the box, labeling and putting it aside.	1. Both Hands (L:R = 4:3) 2. Standing 3. Shift Duration: 4hr 4. Weight 150g 5. Sometimes have to take rejected bottles from the ground	1. Moore-garg strain index (SI) 2. Rapid Entire Body Assessment (REBA)
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.	1. Both Hands (L:R = 1:1) 2. Sitting 3. Weight 100g 4. Shift Duration: 4hr 5. Flow of the filling machine is continuous 6. Has to abduct his arms while taking and keeping the bottles	1. Moore-garg strain index (SI) 2. Rapid Upper Limb Assessment (RULA)

5	Taking the sachets of shampoo from the conveyer belt, folding them together and putting them aside using both hands	1. Both hands (L:R = 1:1) 2. Sitting 3. Weight 300g 4. Shift Duration: 4hr 5. Speed of conveyer belt is constant and worker cannot control 6. Sits in a chair not close to the table 7. Shoulder remains elevated during work	1. Moore-garg strain index (SI) 2. Rapid Upper Limb Assessment (RULA)
6	Taking the empty bottle from container and putting them into the slots of automated conveyer chain with both hands.	1. Both hands (L:R = 1:1) 2. Standing 3. Weight 30g 4. Shift Duration: 4hr 5. Speed of conveyer belt is not controlled by the worker 6. Raise arm, grab bottle, push in	1. Moore-garg strain index (SI) 2. Rapid Upper Limb Assessment (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.	1. Both hands (L:R 1:1) 2. Standing 3. Weight >1kg 4. Task Duration: 4hr 5. Hold bottle, hit the hammer, place on conveyer. Sometimes fwd bending while placing the bottle.	1. Moore-garg strain index (SI) 2. Rapid Upper Limb Assessment (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.	1. Both hands (L:R 1:2) 2. Standing 3. Work place is congested and restricting free movements 4. Table ht: 31inch box ht. 14inch	1. Moore-garg strain index (SI) 2. Rapid Upper Limb Assessment (RULA)
9	Taking a sac of chemical powder, lifting and carrying up to the feeder and emptying on the vessel.	1. Both hands (L:R 1:1) 2. Lifting and carrying 3. Weight 25 – 35 kg 4. Shift duration: 3hr 5. Raise the sac, carry and pour it in a container.	1. Rapid Entire Body Assessment (REBA)

The RULA scores of the tasks 2, 4, 5, 6, 7 and 8 are 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 are assesses 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 GARG (Garg) Strain Index score for the measurement of exertion, efforts per minute, hand or wrist posture and speed of work are calculated and the eight tasks (except task 9) that were calculated are described in Table Fig 1.

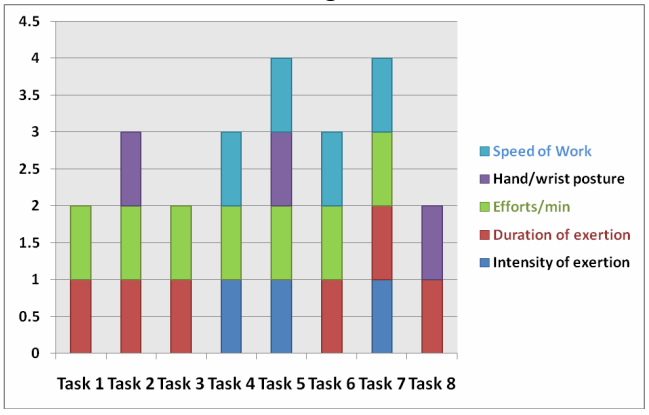

Fig 1: Moore – Garg strain index value for the high risk tasks

DISCUSSION

The result of this study provides us with a view that there is definitely a presence of postural and distal upper extremity postural risk factors for the assembly line workers in the evaluated cosmetic industry. Based on the results obtained, appropriate recommendations were given for each of the analyzed nine tasks based on the severity and in an effective manner focusing both for the benefit of the worker and the employer. Modifications were done accordingly in the concerned areas. The analyzed high risk tasks and its recommendations are provided in Table 4.

Table 4: Ergonomic Recommendation for the high risk tasks of the cosmetic factory

TASK	TASK DESCRIPTION	RECOMMENDATION
1	Pasting Literature on the product bottles in the conveyer belt	1. Mandatory micro breaks (3 mins for 30 minutes) 2. Slowing the pace of the conveyer belt by 20% to reduce repetition 3. Provision of a foot stool or sit-stand chair (high chair with Lumbar support and foot rest)
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.	1. Engaging 2 workers to reduce frequency of hand activity 2. Micro-breaks (2mins for 30-40 minutes) 3. Table shifted to 30 inches near the conveyor opening to reduce the reach and forward bending 4. Placing big boxes sideways instead of forward to minimize risk
3	Taking the packed bottles from the conveyer belt and putting it on the boxes then packing the box, labeling and putting it aside.	1. Cut out can be made on the left side of the table to allow the worker to come closer to the conveyer
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.	1. Changing the position of conveyer belt so that the entire filling process comes in one single assembly line 2. Reducing the Height of the container and bringing it closer on the left side 3. Shape of the container can be angulated 4. Height of the table can be reduced by 6-8 inches to avoid obstruction 5. Height of chair / filling machine should be increased to reduce excessive lateral movement of the arm 6. Micro-breaks (3 mins for 30 minutes)

5	Taking the sachets of shampoo from the conveyer belt, folding them together and putting them aside using both hands	1. Changing the position of the worker to be in parallel with the conveyer belt to prevent shoulder raise 2. High stool with lower lumbar support with foot rest to prevent over-reaching 3. Increase table height for making adequate knee space
6	Taking the empty bottle from container and putting them into the slots of automated conveyer chain with both hands.	1. Increasing the height of platform by 8-12 inches to give a height advantage 2. Anti-fatigue rubber matting to decrease the accumulated stress 3. High lab stool for sitting 4. Reducing speed of conveyor by 10% 5. Micro-breaks (4mins for 30-40 minutes)
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.	1. Shift rotation every 2 hrs will reduce that strain index by half 2. Anti-fatigue rubber grip for the hammer 3. Providing automated capping machine, so that the worker can be utilized in other works
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.	1. Rearranging workplace by replacing one big table with 2 small tables on either side of the conveyer to eliminate the trunk twisting movement 2. Adjustable footstool / platform to cover for people of various anthropometry 3. Height of the table can be adjusted by providing a lift table instead of fixed 4. Carton table can be aligned lengthwise instead of widthwise to free up the work-space without twisting the body
9	Taking a sac of chemical powder, lifting and carrying up to the feeder and emptying on the vessel.	1. Providing height adjustable lift table with wheels to reduce postural risk 2. Educating on proper lifting and carrying techniques to minimize back strain

CONCLUSION

This study enumerates the possible ergonomic risk factors that might predispose to WRMSD among a group of workers in semi-automated assembly lines of a cosmetic factory. This will help in focusing attention towards workers in assembly line to have a proper working job design and appropriate modifications wherever necessary, thereby making the worker to work efficiently without the risk of developing any work related musculoskeletal disorders.

REFERENCES

1. Shahnavaz H., (1987). Workplace injuries in the developing countries. *Ergonomics*, 30, 397 - 404.
2. Shikdar AA, Sawaqed NM, (2003). Worker productivity, occupational health and safety problems in selected industries. *Computers and Industrial Engineering*, 45(4), 563 – 572.
3. Konz S., (1995). Work design: industrial ergonomics. 2nd ed. *Columbus*, OH, USA: Grid.
4. Higuchi Y, Funahashi A, Izumi H, Kumashinro M., (2012). Relationship between performance rating and risk of low back pain in manufacturing line workers, *J UOEH.*, 1, 34(1), 47 - 55.
5. Wilson JR, Corlett EN., (1992). Evaluation of human work: a practical ergonomics methodology. Philadelphia, PA, USA: Taylor & Francis.
6. McAtamney L, Corlett E.N., (1993). RULA: a survey method for the investigation of work-related upper limb disorders, *Applied Ergonomics*, 24, 91 - 99.
7. Hignett S, McAtamney L. Rapid entire body assessment (REBA). Appl Ergon. 2000;31(2):201-205.
8. Moore JS, Garg A, (1995). The Strain Index: A proposed method to analyze jobs for risk of distal upper extremity disorders; *Am. Ind. Hyg. Assoc. J.* 56:443 - 458.