Ergonomic Risk Factors for Workers in Garments Manufacturing – A Case Study from Pakistan

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Abstract –This cross-sectional study aimed to serve as pilot investigation to identify the level of ergonomic risk among the workers of a garments manufacturing industry. The study was conducted for both male (54) and female (26) workers working in two different departments - stitching and finishing. Both direct observation and questionnaire were used to collect data. The cumulative scores of discomfort for each body part as well as for each worker were calculated. The lower back was found to be at the highest risk as compared to other body parts. Female workers had higher score of discomfort (mean = 2.9615, S.D = 1.3931) as compared to their male counterparts (mean = 1.2693, S.D = 0.6538). Similarly, standing workers suffered more discomfort (mean = 2.7272, S.D = 1.3090) as compared to sitting workers (mean = 1.0909, S.D = 0.3784). However, the number of years at job was not found to be related with the level of discomfort. For objective assessment, rapid upper limb assessment (RULA) was used to analyze sitting posture and rapid entire body assessment (REBA) for standing posture. No worker received acceptable score for both of these assessment tools. The mean RULA score was 5.25 and mean REBA score was 5. The results of this study necessitate a company-wide ergonomic assessment immediately.

Keywords: Discomfort; Ergonomic Assessment; Garments Manufacturing; Musculoskeletal Disorders

I. INTRODUCTION

Garments manufacturing industry is highly labor-intensive especially in developing countries like Pakistan. Most of the times the labor has to work in adverse conditions. The working generally consists of long hours with one lunch break in the middle of the day. These workers are rarely provided with appropriate workstations and weak social infrastructure adds to the risk of discomfort and illness. But such risks are rarely investigated at workplace. As a result, it remains unclear whether working conditions or social factors outside the factory cause these problems. Little work has been done to investigate the risk of disorders in garments manufacturing as compared to other areas of work [1,2]. A study of ergonomic risk factors for female Turkish sewing operators showed high posture scores (RULA score of 6.9) and risk of musculoskeletal disorders [3]. About two-third of the operators had suffered from one or more musculoskeletal disorders during the last six months.

The present study was conducted in a plant of one of the largest garments manufacturers in Pakistan. The industry had a well-established department for “safety” issues, but little attention was formally paid to “health” problems at workplace. This study was conducted to act as a pilot study to give initial picture for what was planned to be an industry-wide ergonomic assessment program.

The goal was to investigate major ergonomic risk factors that could ultimately result in occupational illness. The results of this pilot study were supposed to be critically analyzed and act as initial evidence for a complete ergonomic assessment. It was aimed to find the potential areas for improvement and to provide guidelines for safe and comfortable working conditions.

The term musculoskeletal disorders (MSD) is used to refer to injuries and illnesses of different body structures involved in movement. The symptoms usually include pain and discomfort in body parts including upper limbs, back and lower limbs – upper limbs and back has been reported to suffer more [3,4]. There are a variety of terms used to refer to these disorders - in the USA, cumulative trauma disorders (CTD, in Japan occupational cervicobrachial disorders (OCD), and in Australia repetitive strain injuries (RSI) is used to describe them. In recent days a new term occupational overuse syndrome (OOS) is also used [4,5]. Whatever the word used to describe them, these disorders are the major cause of illness and injuries at workplace [6].

The working posture of the workers in the case industry was not proper. The seated workers had to sit day long on a stool without a back support. Also, the standing workers were trying to balance their day long activity by supporting at one leg only. A number of WMSDs could occur across these workers. Some example postures are shown in Fig. 1.

(a) (b) (c)

Fig. 1. Example postures of workers (a), (b) seated, (c) standing

II. METHODOLOGY

This is a cross-sectional study conducted in a garments manufacturing factory that manufactures and exports denim jeans. Fabric is received in the cutting department in rolls and cut in the required patterns that are then sent to sewing machine operators. Pieces sewn are sent to the washing department where they are dried. The dried pieces are sent to finishing department where a number of tasks are performed. The final product (denim jeans) are sent to ironers where they are pressed and packed after inspection. The manufacturing continues on an 8-hour/ day based shift system [7].

The sample comprised 80 workers (54 males, 26 females). The two departments for this study were selected, in which 47 workers were from stitching and 33 were from finishing department.

III. DATA COLLECTION AND ANALYSIS

In this study, both direct observation and questionnaire were used to collect data about study participants. Discomfort survey questionnaire by Industrial Accident Prevention Association (IAPA) was used for this study [8]. The workers were asked to indicate if they had experienced discomfort, fatigue, or pain during the last one year. The 4-point scale was used. Total 80 questionnaires were got filled by the workers of stitching and finishing departments. On average, one questionnaire had taken 10 to 15 minutes to be filled. The summary of scores is shown in TABLE I.

TABLE I. Summary of discomfort for different body parts

Body Parts	**Mean**	**SD**	**Body Parts**	**Mean**	**SD**
Neck	2.03	1.03	Shoulder	2.33	1.10
Elbow	1.48	0.72	Upper Back	2.27	1.09
Forearms	1.73	0.95	Lower Back	2.36	1.10
Wrist/Hands	1.85	1.02	Hips	1.21	0.57
Thighs	1.78	1.11	Knees	1.6	0.80
Ankles/Feet	2.23	1.24	Lower Legs	1.84	1.02

Rapid upper-limb assessment (RULA) [9,10] is used to assess risk of musculoskeletal orders for tasks in which upper limbs are predominantly used. This tool has been used and validated by a number of practitioners and researchers and is particularly applicable to sedentary tasks [11,12]. RULA provides a single score, ranging from 1 (lowest) to 7 (highest) to indicate the risk of musculoskeletal disorder based on posture, force and movement. The final score can be converted into one of the four action levels. These action levels indicate the time frame to initiate the change to reduce or eliminate the risk [9,10]. The working postures were evaluated through direct observation by using RULA tool for seated workers. There were no employees who received RULA score of 1-2 i.e. acceptable posture. Mean RULA score was 5.2 as shown in TABLE II. This score indicates that work posture needs to be immediately investigated and changes in posture are required soon.

TABLE II. RULA score for female and male workers

RULA	Score A		Score B		Grand Score		
	Mean	SD	Mean	SD	Mean	SD	Range
Female	3.8	0.91	3.9	1.19	5.4	1.07	4-6
Male	3.5	0.84	3.7	1.05	5.1	1.10	4-6
Combined	3.6	0.87	3.8	1.10	5.2	1.07	4-6

The scores of upper limb, lower limb and wrist are used to find Score A. Scores of trunk, neck and legs are used to find Score B. Scores of muscle use and force are added to posture score to get the grand score. The grand score range details is shown in TABLE III.

TABLE III. Action level categories of RULA [9,10]

Range	Description	Range	Description
1-2	Acceptable posture	5-6	Further investigation, change soon
3-4	Further investigation, change may be needed	7	Investigate and implement change

Rapid entire body assessment (REBA) [13,14] is used to assess the working postures that are unpredictable. It is an easy-to-use tool to analyze postures involving whole body that can cause risk of musculoskeletal disorders. REBA has been validated in a number of studies and is specifically applicable to situations involving standing postures [11,15]. In the present study no employees received REBA score of 1-2 i.e. acceptable posture. Mean REBA score was 5 as shown in TABLE IV. This score indicates that work postures needs to be investigated and changes in posture are required soon.

TABLE IV. REBA score for female and male workers [13]

REBA	Score A		Score B		Score C		Grand Score		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Range
Female	4.1	1.16	3	1.09	4.1	1.16	5.1	1.16	4-7
Male	3.8	1.34	2.7	0.95	3.8	1.57	4.8	1.57	4-7
Combined	4	1.22	2.8	0.98	4	1.35	5	1.35	4-7

Score A is found by adding the sores of neck, trunk, and legs with load/force score. Score B is found by adding the upper arms, lower arms, and wrists scores with coupling score. Score C is obtained through table with the use of score A and B. The grand scores are obtained by adding muscle activity score. The action categories against final score of REBA is shown in TABLE V.

TABLE V. Action level categories of REBA

Range	Description	Range	Description
1	Negligible risk	8-10	High risk, investigate and implement change
2-3	Low risk, change may be needed	11+	Very high risk, implement change
4-7	Medium risk, further investigation, change soon		

IV. RESULTS

Minitab V. 16 was used to perform statistical analyses of the data. The difference in discomfort score between male and female workers was found to be significantly different ($p < 0.05$), as shown in TABLE VI. This shows that, although overall working conditions are poor, female workers are more at risk.

Further investigations should be made to validate this gender-specifity of ergonomics risk in the case industry. There was no significant difference between discomfort of seated and standing workers ($p > 0.05$), as shown in TABLE VII. The comparison between discomfort score of standing and seated workers, and male and female workers is shown in Fig. 2.

(a) (b)

Fig. 2. Discomfort score comparison between (a) standing & seated workers, (b) male & female workers

TABLE VI. Statistical results of comparison between discomfort of male and female workers

Two-sample T for Male Disc. vs Female Disc.				
	N	**Mean**	**SD**	**SE Mean**
Male Disc.	54	22.24	7.17	0.98
Female Disc.	26	28.73	9.10	1.8
95% CI for difference:	(-10.60, -2.38)			
T-Test of difference =	0 (vs not =): T-Value = -3.19 P-Value = 0.003 DF = 40			

TABLE VII. Statistical results of comparison between discomfort of seated and standing workers

Two-sample T for Sit. Disc. vs Stand. Disc.				
	N	**Mean**	**SD**	**SE Mean**
Sit. Disc.	47	23.62	8.27	1.2
Stand. Disc.	33	25.39	8.54	1.5
95% CI for difference:	(-5.60, 2.04)			
T-Test of difference =	0 (vs not =): T-Value = -0.93 P-Value = 0.356 DF = 67			

The number of years at job was divided into two groups. Group A: workers with work experience of up-to 5 years. Group B: workers with work experience of more than 5 years. There was no significant difference found in discomfort based on working experience ($p > 0.05$), as shown in TABLE VIII.

TABLE VIII. Statistical results of comparison between discomfort based on number of years at job

Two-sample T for Discm. < 5 Yrs vs Discm. > 5 Yrs				
	N	**Mean**	**SD**	**SE Mean**
Discm. < 5 Yrs	57	24.07	8.73	1.2
Discm. > 5 Yrs	23	25.70	7.61	1.6
95% CI for difference:	(-5.58, 2.33)			
T-Test of difference =	0 (vs not =): T-Value = -0.83 P-Value = 0.412 DF = 46			

V. DISCUSSION

This study was one of the initiating attempts to assess the working conditions from ergonomic point of view in the case garments manufacturing industry. The discomfort was found to be high among the population studied. The level of musculoskeletal symptoms was significantly higher in females, and the mean severity of shoulder, upper back and low back symptoms was greater in females than in males. Also these symptoms were severe in standing workers than sitting workers, although the difference was not significant.

Sitting uses less energy and helps to stabilize the body. Standing workstation fixes a person's posture which can compromise their wrist posture, thereby increasing risks of injury such as carpal tunnel syndrome. Increases pressure on cartilage in the knees, hips and balls of the feet. Requires 20% more energy than sitting placing greater strain on the circulatory system [16,17]. For standing workers alternate sit stand workstation is more appropriate as it provides most safe posture & it will balance the day long activity. As the workers in stitching department were maintaining a seated posture for the whole day, so an ergonomic chair with a back support should be provided for these workers. As this was first study of this kind in the sample industry, further investigation is required to validate the results. However, it is apparent that the workstations are poorly designed and some macro-level steps are immediately required. These may include providing back-support for seated workers and modifying the nature of task for standing workers. This could be redesigning the task to sit-stand or providing more frequent breaks of less time. The female workers are more prone to ergonomics risks as compared to their male co-workers, and their tasks need even a more immediate intervention.

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