Analysis of Work-Related Muscular-Skeletal Disorders among Employees in Garment Industry

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Abstract: Major portion of the small-scale industries is governed by the garment industries. The survey of theses industry working environment scenario specifically component storage and manufacturing units reveals that the workers are facing several health problems mostly Postural analysis of employees’ activities which result in a high prevalence of musculoskeletal disorders. This paper gives the recommendation on appropriate postures practice for the employees to reduce the WRMSD’S and improve the health storms there by financial overhead for the industry. The paper recommends the list of prescription and exercises for affected employees.

Keywords: Postural analysis, Ergonomic Interventions, Musculoskeletal disorders.

1. INTRODUCTION

The textile and apparel industry can be broadly divided into two segments namely yarn & fiber and processed fabrics, readymade garments and apparel. India is the world’s second largest producer of textiles and garments. The sector contributes 14% to industrial production and 4% to Gross Domestic Product (GDP). With over 45 million people, the industry is one of the largest source of employment generation in the country. Readymade garments was the largest contributor to the total textile and apparel exports from India with a share of about 40 %. The size of India’s textile market in 2016 was around US$ 137 billion, which is expected to touch US$ 226 billion market by 2023, growing at a CAGR of 8.7 per cent between 2009-23. The new textile policy, which is in final stage, aims to achieve US$ 300 billion worth of textile exports by 2024-25 and create an additional 35 million jobs. [1]. The garment industries in Karnataka State are concentrated in Bangalore and some of the largest export houses of the country are existing. Today overseas buyers view Bangalore as an important location for sourcing of garments after Bombay and Delhi [2]. The industry thrives on the abundant supply of unskilled and cheap work force majorly dominated by females, which includes migrants from different parts of the country [3]. However, majority of the units fail to achieve Excellent standards due to low technological development and poor working conditions.

Ergonomics is a science that focuses on designing a job for the worker and aims at preventing injuries by controlling the risk factors such as force, repetition, posture and vibration that causes injuries and other disorders [4]. Work related musculoskeletal disorders (WMSD’s) are diverse disorders that may affect different structures: tendons, muscles, joints, nerves, and the vascular system. Depending on the structure affected and the type of affliction, the ailment would be referred to as tendonitis, tenosynovitis, bursitis, carpal tunnel syndrome, etc. They are a major problem with serious consequences for workers, organizations and society in general. They develop gradually due to the over use of musculoskeletal system. The seriousness of risk factors depends on three major modulators namely intensity, frequency and duration [5].
Simultaneously a tailor who has expertise in garment making prepares the patterns, which are used by the cutting section to cut the layers of fabric. Depending on the requirements the stores sends the finished The manufacturing of a garment starts with designing and sampling of garment as per the customer requirements/acceptance. The manufacturing unit procures the raw material in terms of grey fabric and other accessories (bleached/dyed/printed as the case requires) is sent to cutting section for further process. The cut components are sent to sewing section for fabricating the garment, which also includes value addition activities such as embroidery, needlework, etc. The fabricated garment is further checked for standards by the finishing department and made ready for packing and dispatch [2].

Ergonomics principles play a very crucial role in designing the macro and micro aspects of work at each stage of garment manufacturing process. It considers environmental, physical and cognitive aspects of work design. The posture adopted by the worker is determined by various aspects associated with workstation design in each of these departments. Failure to consider ergonomic principles will result in work related musculoskeletal disorders among the workers. Several studies carried out in Indian context with a focus of suggesting necessary ergonomic interventions were primarily focused on sewing and cutting sections in garment manufacturing units. No literature in Indian context, reports thorough ergonomic analysis of physical work in raw material stores. [8]

Earlier research works carried out reveal that the nature of activities such as sustained work postures, highly repetitive actions, and strong visual demands performed by the workers in garment manufacturing units result in high prevalence of work related musculoskeletal disorders. The major health risks in this industry don’t arise from immediate potentially fatal hazards. Instead, the risks that workers face come from more subtle hazards whose effect accumulates over time. The garment manufacturing industry is generally considered as a safe place to work when compared to other manufacturing units as there are relatively few serious accidents [6, 7]. Empirical evidences suggest that the workers in the garment units suffer from work-related musculoskeletal disorders such as carpal tunnel syndrome, forearm tendinitis, epicondylitis, capital tendinitis, lower back pain, neck pain, shoulder pain , osteoarthritis of the knees, my skeletal pain, rotator cuff tendinitis, cervical spondylitis, tennis elbow and golfers elbow [8,9]. The WMSD’s involved among garment workers depended on factors such as duration of work, length of service, socio-economic conditions, general physical conditions and stress at work place. It may also be noted that the most common cause for WMSD’s among employees in garment manufacturing units is also due to Vitamin-D3 deficiency. Bad lighting intensity and lack of exposure to enough sunlight lead to vitamin-D deficiency, which aggravates the susceptibility of workers to WMSD’s [9].

In Indian medium and small-scale units manual work is preferred over automation because of the availability of skilled and cheap work force. The ergonomics in sewing and cutting sections is critical area for research. The stores division activities are still predominantly manual in nature and a much-neglected area. The effort expended by the workers is much high in Health.

1.1. Motivation and Objectives of Applied Research

Garment manufacturing is a manual intensive work. Researchers suggest that there have been efforts world over as well as in India to automate various activities in garment manufacturing for enhancing productivity and quality. However, these efforts are restricted to automate mainly the this area of work. Even the manufacturing unit management considers stores as a subsidiary activity and not much attention is paid. The workers in this division are unskilled and unaware of the benefits of working in an ergonomic environment. They neglect the ill effects of bad ergonomics as the disorders get manifested over a lengthy period of time. The type of work 3 Involving the awkward postures, effort& force, repetition, mechanical pressure along with organizational factors lead to the occurrence of WMSD’s. Prevention is an effective means of combating WMSD’s, if action is taken early enough in the process. Hence, it is considered appropriate to choose this area for ergonomic evaluation. This research focuses on the postural analysis of the employee’s repetitive activity of carrying raw material manually to cutting section in the garment-manufacturing units and suggesting feasible ergonomic interventions and prescriptions to prevent possible musculo-skeletal disorders.

1.2. Text Organization

The paper is organized as follows; chapter 1 provides the motivation to the research with potential fatal hazards. Chapter 2 provides the methodology of research conducted to evaluate the posture selection, chapter 3 gives the recommendations based on the prescriptions, and finally the paper is concluded.

2. METHODOLOGY OF RESEARCH

The applied research adopted a methodology comprising preliminary study, questionnaire administration, identification and selection of postures for analysis, appropriate tool and expert system selection for analysis documentation of the outcomes.

2.1 Preliminary Study:

To conduct this research work, the investigator visited five medium scale-manufacturing units in the city of Bangalore for duration of twenty weeks. An initial walk through study of different sections in manufacturing units was done to observe the activities carried out in the manufacturing of garments and get a feel of general work environment in the units [12]. During the interaction with the management, it was learnt that these units hire the services of medical consultants but database of the type of health issues for which the workers are consulting them is not maintained.
2.2 Questionnaire Design and Administration:
As the health database of employees is not maintained by the units, the author designed a questionnaire. The questionnaire is designed to obtain information pertaining to work environment, discomfort experienced in various body elements and workstation design from the employees. Since, the focus of investigation is to undertake the risk assessment of musculoskeletal disorders the investigators administered the questionnaire to employees and obtained primary information about the ergonomic related issues from the workers. The consolidation of the survey findings revealed that the majority of the employees across different divisions experienced discomfort in neck, thorax, lumbar, shoulder, elbow, wrist, buttocks, knee and ankle at different points in time.

2.3 Identification and Selection of Postures for Analysis:
The authors considered the primary operation of ‘lifting and carrying the fabric’ as shown in Figure 3.1 for further ergonomic analysis and this activity was observed in all units considered for the study.

![Figure 2.1: Employee handling raw material](image)

The operation involves the employee lifting the raw material onto his shoulders and delivering it to the cutting section. This operation is of utmost importance as it the first operation, which initiates the entire process in the manufacturing unit. The entire operation is divided into three significant postures for analysis. The three postures are employee bending to pick up raw material, employee picking up raw material and employees loading the raw material on to the shoulder, carry to cutting section are depicted in Table 2.1. The employee usually takes up to 20 kg load of fabric where each individual unit of raw material weighs about 540 gm. Due to consistent loading on the left shoulder throughout the delivery process, the worker adopts bend posture towards right side. In all the units, it was observed that only one worker is assigned to this job.

2.4 Selection of Tools for Analysis:
There is plethora of tools available for ergonomic analysis. However, based on the relevance for the activity under consideration for postural analysis the investigators have selected REBA, RULA, NIOSH Lifting Equation and Rodger’s Fatigue Model.

The REBA assess the risk factors involved in the job which affects various body parts such as neck, upper limb and lower limb [13, 14]. Using quantifiable action levels, REBA effectively ranks employee exposure to hazardous postures helping management determine the necessary corrective actions [14]. This tool is more suitable for this study as it specifically takes into account neck, trunk, arms, wrist and legs.

RULA is a quick and systematic assessment tool for determining postural risks to an employee and it can be used pre and post intervention stages to determine the success of lowering the possible risk of injury [13]. The RULA assessment has a four level coding system that determines the priority for ergonomic change of a task to reduce the risk of work related musculoskeletal disorders. This tool is appropriate in this context as the focus is on neck, trunk and upper extremities.

The muscle fatigue assessment method developed by Rodgers and Williams assess the amount of fatigue that accumulate in muscles during various work patterns within five minutes of work. Usually applied to characterize the discomfort experienced by the employees engaged in automobile assembly lines and fabrication tasks can be extrapolated to the activity selected for the study. [15, 16].

The NIOSH lifting equation is a method of risk assessment of low back disorders in jobs involving repeated lifting [18].

\[
RWL = LC \times HM \times VM \times DM \times AM \times FM \times CM
\]

(1)

Task variables needed to calculate the RWL:
- \( H \) = Horizontal location of the object relative to the body
- \( V \) = Vertical location of the object relative to the floor
- \( D \) = Distance the object is moved vertically
- \( A \) = Asymmetry angle or twisting requirement
- \( F \) = Frequency and duration of lifting activity
- \( C \) = Coupling or quality of the workers grip on the object.(M stands for Multiplier)

The equation when applied helps to arrive at the recommended weight limit and lifting index. This equation can be applied to this case as the task involves two handed lifting.

Lifting Index (LI) = \( RWL / \text{Weight} \)

(2)

Additional task variables needed to calculate the LI:
- Average weight of the objects lifted
- Maximum weight of the objects lifted

2.5 Selection of Expert System: The analysis for this study is carried out with the aid of ergonomic expert system “ERGO FELLOW”. The expert system consists of seventeen tools to evaluate and provide information for work place improvements that help in reducing occupational risks and productivity enhancement.
The effort levels in terms of Light, Moderate, Heavy and Very heavy along with the duration of continuous effort and effort frequency are taken as input by the system to determine the criticality of fatigue accumulation in different elements of the body such as neck, shoulders, back, arms/elbow, wrists/hands/fingers, legs/knees/ankles. The values of horizontal distance of load from the worker, vertical height of the lift, vertical displacement during lift, angle of asymmetry, frequency and duration of lifting and quality of hand to object coupling are entered as input to obtain recommended weight limit and lifting index[17].

### Table 2.1: REBA and RULA scores for different postures.

<table>
<thead>
<tr>
<th>Posture Description</th>
<th>REBA Score</th>
<th>RULA Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bending to pick up raw material</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>Bending to pick up raw material</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Bending to pick up raw material</td>
<td>13</td>
<td>9</td>
</tr>
</tbody>
</table>

**2.6 Outcomes of the Investigation:** The REBA and RULA scores for the three identified postures bending, picking up and loading of raw material are given in Table 2.1. The REBA and RULA scores of 11 and 7 clearly indicate that there is a high risk associated with the first and third postures and requires immediate implementation of change.

In Rodger’s fatigue model the input value is given very heavy for arms and elbow, heavy for shoulders, moderate for neck, back, and legs and light for wrists and related parts to determine fatigue accumulation criticality. The output frame in Fig: 2.2(a) show that the levels of fatigue accumulated in different parts of the body namely arms, shoulders, neck, back, legs and hands is high and necessitates very high Priority for change, which is also represented through color-coding with red.

Analysis of posture using NIOSH equation indicates that the lifting index is 1.217 in Fig: 2.2(b), which is higher than the permissible limit of 1 and indicates a very high risk of developing lower back disorders due to repeated lifting. Also the recommended weight limit of 8.219kgs When compared with the actual weight of 20kgs indicate the high risk probability of Musculoskeletal disorders like rotor cuff tendinitis, back and neck pain [19].

### INTERVENTIONS AND PRESCRIPTIONS

Based on extensive literature review and study an appropriate set of postural corrections as Shown in Figure 3.1 were suggested for this case, which can help in the reduction of body discomfort [18].

The postural corrections help in improving the grip, reduction of stress on back and shoulders, reduction of effort to perform the task. Also it was suggested to follow the recommended weight limit of 8.2 kgs load as obtained in the NIOSH equation analysis the authors have provided basic training to the employees on the benefits of practicing correct postures during work. Certain immediate interventions in the form of stretching. Exercises have been listed that include axial extension, neck side bending, shoulder pendulum, Back extension, wrist/finger extension and wrist finger flexion. The investigators also suggested the management of the units to follow the job rotation policy, Maintain a database of affected workers for further follow up along with organizing workplace fitness programs at defined schedules. The authors provided a list of medical prescriptions to be followed for immediate treatment of affected employees. They can be provided with ice pack treatment, short course of non-steroid anti-inflammatory drugs (NSAIDS), and physiotherapy treatment such as Transtutaneal electrical nerve stimulation (TENS) which uses electric current pressure by a device to stimulate nerves for

### 3. RECOMMENDATION OF ERGONOMIC
therapeutic purposes and screening and medication for vitamin-D3 deficiency [9].

![Figure 3.1: Suggestive safe postures]

**CONCLUSION AND FUTURE SCOPE OF RESEARCH**

The authors have selected a crucial activity of “lifting and carrying the fabric which is generally overlooked by researchers and management for postural analysis and have offered immediate and long term interventions and medical prescriptions to improve the working conditions. The REBA and RULA scores of 11 and 7 respectively indicated high level of risk associated with the existing postures and required immediate change. Rodgers fatigue model indicated the very high accumulation of fatigue in neck, shoulders, back, arms, hands and legs and requires very high priority for change of postures. The NIOSH equation is applied to the postures to arrive at recommended weight level and it is 8.21kgs.

During the investigation, it was also revealed that lack of awareness about the advantages of ergonomically designed work environment both among the management and among employees is primary reason for prevailing bad ergonomic environment especially among the middle and small-scale garment-manufacturing units. It is necessary for the manufacturing units to implement sustainable ergonomic control process to identify and remove ergonomic risk factors on a continuous basis along with individual controls. Implementing an effective health monitoring system can reap huge benefits to the garment-manufacturing units. Also in the long term the units can look into the feasibility of automating the storage and retrieval systems to eliminate the ergonomic factors that pose risk to employees in the form of musculoskeletal disorders. The garment manufacturing industry in India offers significant opportunities for the researchers to contribute solutions for betterment of work conditions from ergonomics perspective.

**REFERENCES**


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Dr. K.V. Manjunath is working as assistant professor at Siddaganga Institute of Technology, Tumkur. He has 17 years of teaching experience with bachelors and masters degrees in Bangalore university. He has obtained doctoral degree from the VTU belagavi, in the area of ergonomics and work-study.