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Ergonomic Analysis of Musculoskeletal Issues in Indian Footwear Factory Workers

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Abstract: ***Objectives:*** ***The musculoskeletal problems have become a major issue to many industries in our country. The footwear industry is an emerging and hazardous industry, making it important for ergonomic aspects to be implemented on site. Ergonomic studies in industrial workers were many but there are little literatures regarding the physical issues of the footwear factory workers. Therefore, a need was felt for ergonomic study to take up the issues of small- scale labour-intensive footwear industry.*** ***Methodology:*** ***250 subjects, were assessed using the following questionnaires. RULA (Rapid Upper Limb Assessment), Nordic questionnaire, Visual Analogue Scale.*** ***Results:*** ***Our study showed that 88% of the subjects suffered from at least one work-related musculoskeletal pain in relation to the type of work. It was investigated factory workers reported discomfort in different parts of their body. But neck, elbow, back and knees were found major areas of discomfort. Musculoskeletal discomfort was measured on VAS scale .Intensity of pain were mostly varies between 2 to 5 but most of them have pain in range of 4 to 5. On the analysis of risk of developing musculoskeletal disorders by workers with the help of RULA scale ,it was found that 32% of the workers were on the high risk with RULA score of 6 and above where as 44% were on medium risk with RULA score of 5 to 6 of musculoskeletal disorders.*** ***Conclusion:*** ***The workers were at high risk of developing musculoskeletal problems. Our study highlighted that workers were doing their work in faulty body postures; they were using their joints in above normal range which could increase the risk of musculoskeletal problems in them.***

Keywords: Footwear factory workers, Musculoskeletal Discomfort, Musculoskeletal Pain Ergonomics

1. Introduction

Ergonomics, as defined by the Board of Certification for Professional Ergonomists (BCPE), "is a body of knowledge about human abilities, human limitations and human characteristics that are relevant to design. Ergonomic design is the application of this body of knowledge to the design of tools, machines, systems, tasks, jobs, and environments for safe, comfortable and effective human use" (BCPE, 1993) . There is strong relationship between the occupational stress of workers and their productivity. The occupational stress is an unavoidable part of working life. Occupational health majorly concerned with safety and satisfaction of the workers, as well as its aim is to improve the productivity.[1]

Working environment and wages in India are different from the ones in western countries. The working days for factory workers in India usually runs six days a week. Long work shifts and changes in working schedules are the common reasons for different health related problems.[2,5] The musculoskeletal problems have become a major issue to many industries in our country. The footwear industry is an emerging and hazardous industry, making it important for ergonomic aspects to be implemented on site.[3]

Upper-extremity and back musculoskeletal disorders are highly prevalent in footwear factory workers Job features that increase the risks of work related musculoskeletal disorders are heavy lifting, repetitive hand motions, static work in which the body is maintained in a fixed or faulty posture, vibrations and any of these in combination along with an undesirable psychosocial work environment. Footwear factory workers often have complaint of Upper-extremity musculoskeletal problems as they have to perform heavy lifting, repetitive hand movements, and packaging.[5]

In several countries, particularly in India as a developing country, neck and shoulders pain had been recognized as important causes of disability and morbidity in workers. Several studies supported a high prevalence of neck and spinal disorders among industrial workers compared to the general population and even office workers [4]

The Footwear industry covered under this study was labour intensive and therefore it was considered necessary to study their health problems. Ergonomic studies in industrial workers were many but there are little literatures regarding the physical issues of the footwear factory workers. Therefore, a need was felt for ergonomic study to take up the issues of small- scale labour-intensive footwear industry.

The aim of this study is to highlight problems physical health of the footwear factory workers and analyse the different factors associated with it and to find out the possible solutions.

2. Material and Methods

Subjects

Cross-sectional survey was conducted in small scale labour-intensive footwear factory of West Delhi, India for the period January 2018 to February 20018. In this study out of 250 workers ranging between 30 to 50 years were selected by convenient sampling from volunteers after taking consent from them. Workers with a background of cardiac, respiratory diseases or accidents affecting musculoskeletal system, unable to respond to the questions (due to hearing problems or any other reason) and not willing to participate were excluded.

Procedures

Necessary permission was obtained from the head of factory for the survey. The purpose of study was explained to all the eligible participants in their local language. Verbal consent and written consent were obtained from all who elected for the participation in the survey. Data was collected by face to face interview method using questionnaires. Questionnaires were filled by the investigators at the time of interview. Among the problems identified, the ergonomically related health problems pertaining to musculoskeletal, safety problems and faulty postures were selected for the study. Following that all the participants were explained about different problems and solutions related to life style, physical health and well-being. At last they were explained about the correct postures, right lifting techniques, joint protection techniques and they were also given a patient education booklet explaining safe, healthy, and efficient life style, emphasizing the physical and mental health status and wellbeing of footwear factory workers.

Outcome Measures/Scales

Visual Analogue Scale (VAS)

The VAS is a common scale used to measure the intensity of pain (Huskisson, 1982). It is a 10 cm line with anchors of ‘no pain’ and ‘worst pain possible’ with a score of zero and ten respectively. The VAS is a simple, widely used self-report measure that has excellent reliability and validity.

Nordic questionnaire

Standardised questionnaire for analysis of musculoskeletal symptoms in an ergonomic and occupational health context are presented. The questions are forced choice variants and may be either self-administered or used in interviews. The reliability of questionnaire has been shown to be acceptable.[7]

RULA (Rapid Upper Limb Assessment)

A single page worksheet is used to evaluate required body posture, force, and repetition. Based on the evaluations, scores are entered for each body region in section A for the arm and wrist, and section B for the neck and trunk. After the data for each region is collected and scored, tables on the form are then used to compile the risk factor variables, generating a single score that represents the level of MSD risk.[8]

Job Description and Task Analysis

Workers had work in different sections of the factory for example cutting, stitching, finishing, packaging for which they needed combination of body movements involved at the same time. Most of them were having long-sitting and short sitting posture with neck and trunk bent forward with hip and knee flexed. On an average, they usually required eight to ten hours for finishing their daily factory work.

Figure 1: Musculoskeletal disorder risk percentage analysis among factory workers

3. Results

The data were analysed as per the site, intensity of pain and the risk of musculoskeletal disorders involved. Descriptive analysis included percentages.

Table 1: Musculoskeletal disorder risk analysis according to RULA Scores

Total number of workers	At Low risk	At Medium risk	At High risk
250	60	110	80

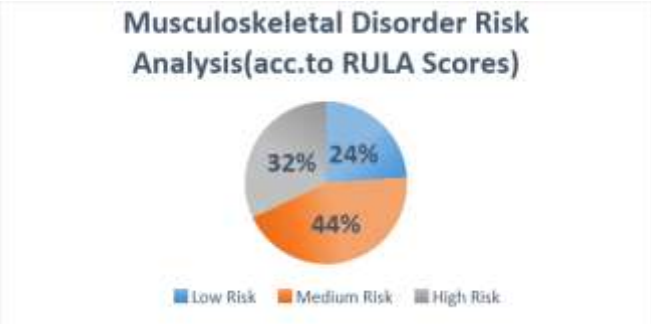
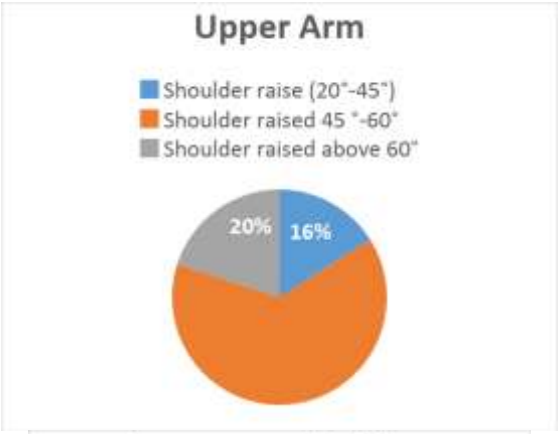
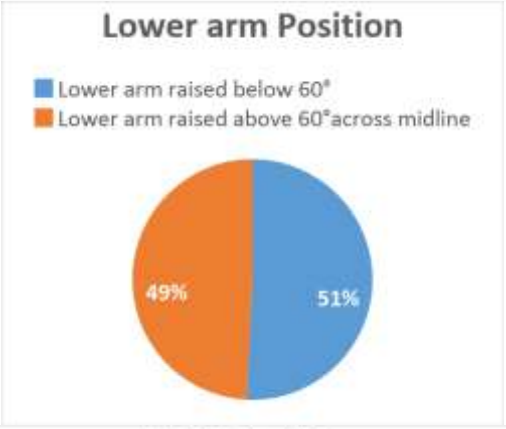


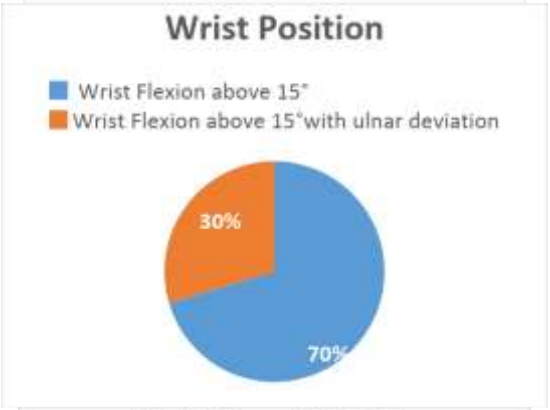
Figure 2: Musculoskeletal disorder risk percentage analysis among factory workers

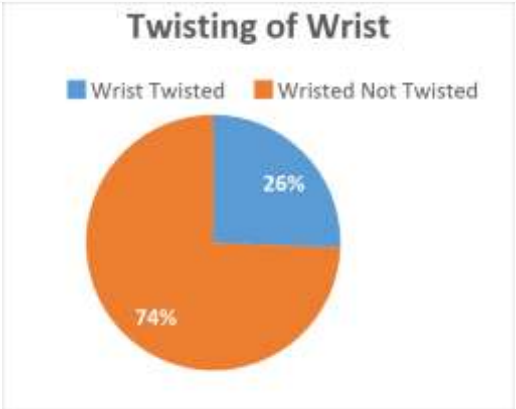
Table 2: Musculoskeletal disorder risk analysis for different body regions according to RULA Scores

Body Region N=250	Type of body movement and number of workers involved		
1.Upper Arm	Shoulder raise 20^o to 45^o 40	Shoulder raise 45^o to 60^o 160	Shoulder raise 60^o and above 50
2.Lower Arm	Raise below 60^o 127	Raise above 60^o across midline 123	
3.Wrist Position	Wrist flexion above 15^o 176	Wrist flexion above 15^o with ulnar deviation 74	
4.Twisting of wrist	Wrist twist 64	Wrist not twist 186	
5.Upper Extremity posture	Faulty 172	Correct 78	
7.Trunk Position	Trunk Bending 0^o to 20^o 60	Trunk Bending 0^o to 20^o 65	Trunk Bending 0^o to 20^o 125
8.Legs Position	Supported 160	Unsupported 90	









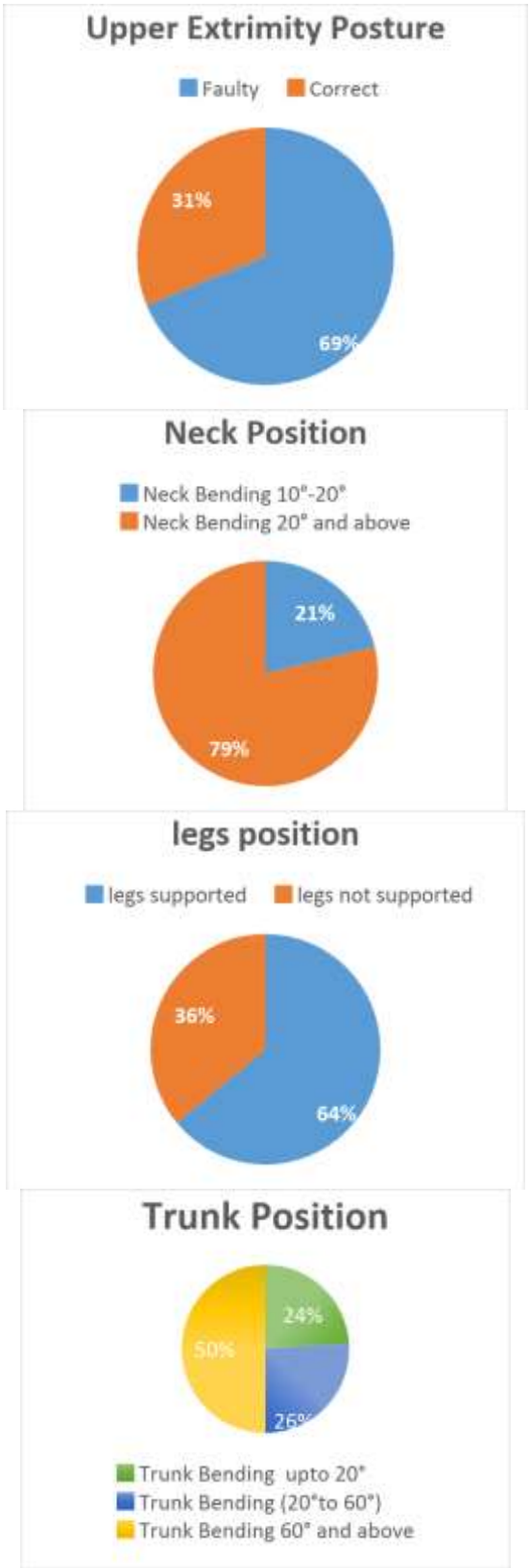


Figure 3: Musculoskeletal disorder risk percentage analysis for different body regions

Intensity of pain

Most of the workers have pain on Visual Analog Scale for score 2 to7. (Figure 6)

Table 3: Musculoskeletal disorder Pain among factory workers

VAS Score	Number of workers
2-3	70
3-4	50
4-5	90
5 and above	40

Distribution of areas of pain and discomfort:

WMSDs and pain were assessed in workers using "NORDIC questionnaire". (Figure 5)

Table 4: Area of Musculoskeletal discomfort among factory workers

Area	Number of workers
Neck	62
Wrist	35
Elbow	38
Back	32
Knees	40
Both Hips	14

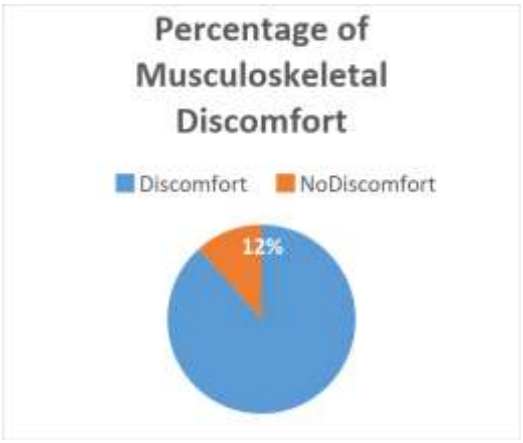


Figure 4: Percentage of Musculoskeletal discomfort

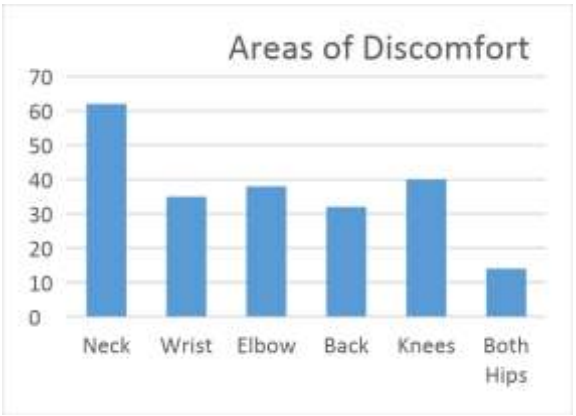


Figure 5: Distribution of areas of discomfort

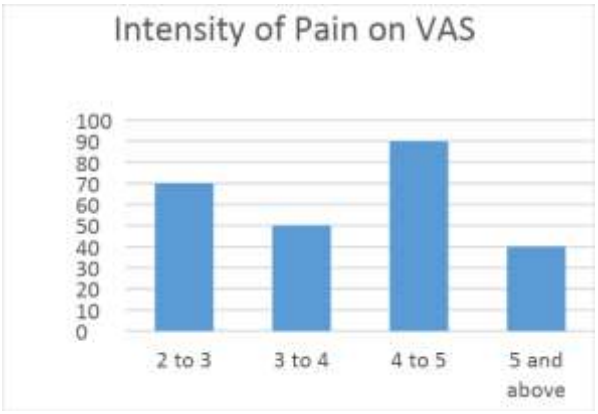


Figure 6: Intensity of pain _

4. Discussion

This study was set out to investigate ergonomic analysis of musculoskeletal issues in Indian footwear factory workers. The sample of 250 Indian workers were analysed on the basis of different outcome measure. Musculoskeletal discomfort was analyzed by Nordiac scale, where areas of distribution of discomfort were marked. Our study showed that 88% of the subjects suffered from at least one work-related musculo-skeletal pain in relation to the type of work (figure4). Similar study was conducted D.C. Metgud, Subhash Khatri, M.G. Mokashi, and P.N. Saha on women workers of woollen textile factory have reported that 91% of the subjects suffered from at least one work-related musculoskeletal pain in relation to length of occupational exposure.[2] This supports our study significantly, however our study is different from this study as in addition to percentage of musculoskeletal discomfort we have done the risk analysis of each body part which can be a cause of musculoskeletal disorders . Work related musculoskeletal discomfort was analysed by NORDIC QUESTIONNAIRE, where different areas of distribution of discomfort were marked. It was investigated factory workers reported discomfort in different parts of their body. But neck, elbow, back and knees were found major areas of discomfort.(figure 5)These results, also supported by other studies,[3,10,11,12] where back and wrist had maximum discomfort.

Musculoskeletal discomfort was measured on VAS scale .Intensity of pain were mostly varies between 2 to 5 but most of them have pain in range of 4 to 5 (figure 6). The important risk of rise in intensity could be to faulty body posture during work, heavy lifting, repetitive hand motions.

On the analysis of risk of developing musculoskeletal disorders by workers with the help of RULA scale ,it was found that 32% of the workers were on the high risk with RULA score of 6 and above where as 44% were on medium risk with RULA score of 5 to 6 of musculoskeletal disorders.(figure 2). Risk factors of different body regions were also analysed to find the wrong postures or faulty joint movements of the workers during their daily factory work. On this analysis, it was investigated that 20 % of the workers raised their shoulder above 60^{O} which could cause shoulder pain and pain in scapular region. Faulty wrist positions, frequent twisting of the wrist were also seen in the workers during their work. Many worker reported pain in neck and back area, when the risk analysis of neck and trunk area was done, many workers were found the bending of neck and trunk above normal range.(figure 3). 69% that is the majority of the workers were found faulty body posture which could result into various musculoskeletal problems.

When the workers were observed and asked about the ergonomics, most of them were unaware of that. It was found that workers didn't want to take rest between their work and also they didn't want to shift their type of work on a regular interval in order to protect risk on one specific joint. They want to accomplish the maximum work for extra cash rewards.

Suggestions for joint protection were given, right method of lifting objects, right body postures were also explained and demonstrated.

Suggestions for the workers

1. The importance of 4 p's for minimising the risk for musculoskeletal disorders: Planning (Plan the work to be done), Prioritizing (Prioritize the work according to the need demand and capacity of the worker), Pacing (short pause of 10 min after every 50 min of work) and Positioning (Correct posture of the body, Avoid the movements which can stress the joints.
2. Use the larger joints in place of smaller joints for example lifting on the back in place of hands.
3. Avoid Staying In One Position For Extended Periods Of Time.
4. Maintain Or Use Your Joints In Good Alignment.
5. Working at the wrong height can lead to a back pain, cervical problems and strained muscles. Factory must be accommodated with a broad range to body heights to ensure that an adjustable, rather than a 'one size fits all', approach is taken.
6. Adjustable back rest and foot rest supporting the lumbar region and foot are recommended to reduce postural strain and low back pain.
7. Handling loads for longer period of time may lead to musculoskeletal problems, therefore right lifting techniques, use of pulley and lifts wherever possible are recommended.

5. Conclusion

Our study is few available studies on the musculoskeletal problems of footwear factory workers. In the factory, incidence of musculoskeletal discomfort and pain was high (88%), indicating that there were definite ergonomic factors responsible for the musculoskeletal problems. On the analysis of musculoskeletal discomfort and pain, most of the workers had pain in some of their body parts. Wrist/hands, neck and back were highly affected areas of discomfort and pain among the sample. The workers were at high risk pf developing musculoskeletal problems. Our study highlighted that workers were doing their work in faulty body postures; they were using their joints in above normal range which could increase the risk of musculoskeletal problems in them.

So based on the observations and analysis made in this study it could be concluded that there is a need for improvement in work design, and working conditions in the factory under study. There is requirement to educate the workers about the correct form of using their joints and the risks factors which can contribute to musculoskeletal disorders .The ergonomic view point is necessary wellbeing.

Conflicts of interest: No conflicts of interest in the study.

Funding sources: Self

Ethical clearance: Necessary permission was taken from the head of the footwear factory to conduct the study. Verbal consent and written consent were obtained from all the Participants.

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