

MUSCULOSKELETAL DISORDERS, STRESS AND THEIR ASSOCIATION WITH BIOMECHANICAL AND PSYCHOSOCIAL FACTORS AMONG FOOTWEAR WORKERS OF AGRA

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ABSTRACT

Shoe manufacturing industry is an emerging and hazardous industry involving enormous labor, low variability of the process and highly monotonous tasks leading to work related Musculoskeletal disorder (MSD) symptoms. Therefore, need of implementation of Ergonomic principles in shoe manufacturing has become very important. Ergonomic studies on industrial and operational workers in large number are available in literature but literature regarding physical issues of shoe manufacturing workers is very limited. Therefore, to resolve physical issues in small and medium labor intensive shoe manufacturing industries, need of an ergonomic study was felt, which was conducted in shoe industries of Agra to find out the association between perceived stress and MSDs and influence of psychosocial and biomechanical factors on symptoms related to musculoskeletal disorder. Two types of industries, old conventional and semi-automatic were selected to conduct the study. Total 435 workers were selected. Finally a sample of 266 was selected. The results of the study showed that MSD symptoms in the various parts were found to be associated with age, inappropriate posture, bullying and perceived effort, very low social support, long time of working in the company and perceived effort were associated with the MSD symptoms. Hence, it has been seen that mainly psychosocial factors and biomechanical factors were associated with MSDs and were having large effect on MSD symptoms occurrence.

Key Words: MSD, shoe manufacturing industries, MSS, ergonomics, workers

1.0 INTRODUCTION

A crucial role in economic development of developed and developing countries is played by Small and Medium Scale Industries (SMEs). At a low capital cost, SMEs help a lot in providing employment and industrialization.. They contribute 40% export of india,7% of gross domestic product (GDP), and help the economy of country with efficient, effective and innovative entrepreneurial spirit. About 60 million people are given employment and more than 8000 products are produced by

16
SMEs. [1]. Health and safety conditions are very poor in comparison to large scale whereas the labor intensity is much higher than large scale[2], [3].

Information about the behavior of human being exposed to work limitations and abilities of the machines, designing about tools, tasks, jobs and environment for safe, effective and comfortable use for the human beings is the basic aim of ergonomics. Ergonomics study has become very important due to the increasingly

requirement of higher production rates and introduction of the new technology to remain competitive in the local and global market. [4]. Ergonomics is concerned with interaction between human and other system's elements to optimize system performance and improve the health of human being [5]. The problems of unorganized and organized sectors are efficiently resolved by optimizing the interaction between human and environment most efficiently by the use of ergonomics principles. (6) Hence an important role to increase productivity, reducing efficiency loss, reduction in MSDs and reduction in absence from the duty is played by ergonomics [7]. There is tremendous pressure on workers due to the increased complexity of products, jobs, global competition, and lean production and cause the work stress [8].

With the introduction of atomization and mechanization, labor oriented industries are also changing towards the trend but general information about safety, environment and occupational hazards were not fully spread in the society. In India large number of persons are working in awkward postures and carrying more loads above their physical capacity, exhaustion and the danger associated with them for small financial gains for earning their livelihood. Since the workers are not having good education, not conversant with their professional hazards, poor knowledge about the sanitation, poor nutritional status increases their health hazards from the working environment [9].

A musculoskeletal disorder is one of a very common problem in service and industrial sectors.. Due to repeated exposures to high-or-low intensity stress over a long duration of time, most of the work related MSDs are recognized as cumulative disorders. Due to the serious social and economic impact, musculoskeletal symptom (MSS) is considered to be a significant health

problem. Neck, low back, shoulder, wrist. Hands, foot, hips and thigh etc. are the most commonly affected body regions [10], [11]. It has been presented in many studies that there are some other risk factors to MSDs like age, gender, Body mass index (BMI), psychological characters, and psychosocial factors [12]. The social consequences of MSS may arise from reduced activities and absenteeism. The World Health Organization reported that musculoskeletal problems are considered to be the most important cause of physical disability. In the literature, prevalence of MSS has been reported at many places but very few information is available regarding their consequences. However, some studies showed that a significant role is played by psychosocial factors in developing MSS [13]. The results of findings also suggest that association between MSS and risk factors is multivariate and complex. But the interaction studies of these individual factors in MSS are very limited.

Awkward postures, force, repetition, temperature, static postures, vibration and contact stress are most likely ergonomic risk factors to cause or contribute to MSDs: [12], [15]. Risk factors like highly repetitive work, lifting, push/pull, forceful exertions, and forceful movements and vibration are found to be associated with increased MSDs [7], [12], [16], [17].

Agra is very famous for the shoe manufacturing. There are about 2500 small and medium scale shoe industries and some of them are exporting shoes to Europe, Brazil, and Mexico etc. Some of shoe industries total manual manufacturing is there whereas some are having automated assembly line etc. Few industries are combination of manual and automated production/assembly lines. In these units some of the operations are performed manually and few operations automatically. Workers in shoe manufacturing units are

working in awkward postures and also involved in carrying heavy loads. Verbal discussion with a group of workers in various manufacturing units have indicated that the workers are very much subjected to work related musculoskeletal problems. The shoe industry covered under the study is labor intensive. Hence, a need was felt to conduct a detailed ergonomical study to evaluate the health problems of the involved workers.

2.0 METHOD

The present study was conducted in small scale labor intensive shoe manufacturing units and semi-automated units of Agra where most of the work is done manually and with little automation. Population size ranging from the age group 18 to 50 years and above considered was 435. Sample Size was calculated by using Sample Size calculator with 95% confidence level, 5% margin of errors with 50% population proportion, the sample size calculated was 266. A Minimum of 266 workers was estimated to be essential to provide a sample of studied population. Workers with the ailment of respiratory, cardiac and hearing problems and persons with accident leading to musculoskeletal problems were not included in the study. To follow the ethics proper care was taken and the present study was approved by all the respondent and Ethics committee review board.

2.1 Data Collection

Data collection was done in the selected shoe manufacturing units, and the questionnaire was given to the participants. Total 30 minutes were given to each participant for filling up the questionnaire. Age, height, body weight, performance of physical activity, marital status, consumption of alcohol, smoking etc. were the considered sociodemographic variables. Body mass index BMI was calculated using weight and height of the respondent. The presence of sleep disorders was investigated

using Effort reward imbalance questionnaire (ERI), Psychological demands, job insecurity, social support of supervisory staff and coworkers etc. were considered as psychosocial variables obtained from job content questionnaire (JCQ). Over commitments and rewards were considered as per ERI. The items such as stress, bullying, job dissatisfaction, Sexual harassment, physical violence etc. were suggested as per the suggestions by Silva, Silva and Gontijo (19). Length of the work at company and participant involvement in performing one or more function was considered as the occupational variables.

Assessment of perceived stress was done using Perceived stress Scale-10 (PSS-10). PSS-10 has ten items each having five possible answers depending upon the frequency of occurrence of the symptoms. For general assessment of stress levels, the questionnaire was consisting of self-reporting symptoms and was having higher reliability for testing and retesting.

For evaluating the presence of MSD symptoms, the Nordic Questionnaire with high reliability and adequate psychometric properties was used. It covers various body parts areas, with Yes or No responses to the MSD symptoms during the last one year and one week.

2.2 Procedure

The data collection in the selected shoe companies was done through the questionnaire by giving 30 minutes to each worker for completing it. Those who were not in a position to read or understand some questions were helped personally by taking oral answers from them.

Collected data were tabulated and using means, percentage and Standard deviation, the results were presented. Level of perceived stress, MSD symptoms and their association was evaluated using Chi-Square test for trends and odd ratio with 95%

confidence interval. Four ranges low, moderate, high and very high were considered for the perceived stress. Statistical analysis was done for the data collected.

2.3 Occupational and Sociodemographic information

Various variables such as gender difference, body weight, height, marital status, smoking, educational status of children, alcohol use, body mass index etc. were considered under sociodemographic information (Table-1)

Table 1: variables used under sociodemographic information

| S.No. | Parameters | Ranges | n (%) |
|-------|------------------------------------|--|--|
| 1 | Workers Participants | Male | 266 |
| 2 | Age | 18-25 Years 26-35 Years 36-45 Years 46-55 Years >55 years | 59 (22.18) 110(41.35) 70 (26.31) 20 (7.51) 7(2.63) |
| 3 | Educational status | Up to Primary Up to secondary Up to Graduation Up to Post Graduation | 27(10.15) 210(80.76) 20(7.51) 9(3.38) |
| 4 | Body Mass Index | Underweight Standard weight Over Weight Obesity | 18(6.67) 141(53.0) 82(30.83) 25(9.4) |
| 5 | Marital Status | Single Married | 114(42.86) 152(57.14) |
| 6 | Sleep Disorder | No Sometimes Regular Always | 193(72.56) 53(19.92) 20(7.52) |
| 7 | Children status | Yes No | 149(56.01) 117(43.98) |
| 8 | Use of Alcohol and Cigarettes | Yes No | 72(27.07) 194(72.93) |
| 9 | Length of service | < 12 Months 12-60 months 61-120 months 121-180 months >.180 months | 57(21.43) 130(71.42) 31(11.65) 29(10.90) 19(7.14) |
| 10 | Involvement in Physical activities | Yes No | 194(72.93) 72(27.07) |

2.4 Psychosocial Factors

Various variables such as psychological demands, job insecurity, supervisor’s social support, co-worker’s social support, job

dissatisfaction, over commitments, bullying, sexual harassment etc. were considered as psychosocial factors (Table-2).

Table 2: Psychosocial factors

| S.No. | Variables | Variations | n(%) |
|-------|-----------------------------|------------------------------|--------------------------|
| 1 | Psychological demands | High demand Low Demand | 169(63.53) 97(36.84) |
| 2 | Job Insecurity | Yes No | 158(59.4-) 108(40.60) |
| 3 | Supervisor’s Social Support | Good Support Poor Support | 123(46.2) 143(53.76) |
| 4 | co-worker’s social support | Low support High Support | 72(27.07) 194(72.9) |
| 4 | Over commitments | No Yes | 128(48.12) 138(51.88) |
| 5 | Job Dissatisfaction | Dissatisfied Satisfied | 153(57.51) 113(42.50) |
| 6 | Sexual Harassment | No Yes | 247(92.86) 19(7.14) |
| 7 | Bullying | No Yes | 221(83.10) 45(16.91) |
| 8 | Reward | Undue reward Fair reward | 113(42.50) 153(57.51) |
| 9 | Discrimination | Yes No | 64(24.06) 202(75.9) |
| 10 | Stress | Yes No | 176(66.16) 90(33.83)s |

2.5 Repetitive Stress Injury (Musculoskeletal Disorders) symptoms in different body regions in the last one week and one year

Table 3: MSD symptoms in a particular year 2020 and one weak

| Body Region | Data Pertaining to Last One Year | | | | Data pertaining to Last one Week | | | |
|----------------|----------------------------------|------|------|-----------|----------------------------------|------|------|-----------|
| | N | % | OR | CI | N | % | OR | CI |
| Neck | 70 | 39.1 | 0.39 | 0.38-0.40 | 13 | 14.8 | 0.15 | 0.12-0.18 |
| Shoulder | 72 | 27.7 | 0.40 | 0.39-0.42 | 20 | 22.7 | 0.23 | 0.19-0.27 |
| Spine | 56 | 21.6 | 0.31 | 0.30-0.33 | 22 | 25.0 | 0.25 | 0.21-0.30 |
| Elbow | 08 | 3.08 | 0.04 | 0.40-0.04 | 02 | 2.3 | 0.02 | 0.01-0.02 |
| Wrist | 37 | 14.2 | 0.21 | 0.20-0.21 | 10 | 11.4 | 0.11 | 0.10-0.14 |
| Lower Back | 69 | 38.5 | 0.39 | 0.37-0.40 | 22 | 25.0 | 0.25 | 0.21-0.30 |
| Hands, Fingers | 83 | 32.0 | 0.46 | 0.45-0.48 | 26 | 29.5 | 0.30 | 0.25-0.35 |
| Thigh | 42 | 16.2 | 0.23 | 0.23-0.24 | 16 | 18.1 | 0.18 | 0.15-0.22 |
| Knees | 63 | 24.3 | 0.35 | 0.34-0.37 | 19 | 21.6 | 0.22 | 0.18-0.26 |
| Ankle Foot | 71 | 27.3 | 0.40 | 0.38-0.41 | 23 | 26.1 | 0.26 | 0.22-0.31 |

Perceived Stress Scale-10 (PSS-10) was used for the analysis of perceived stress. There are 10 items in PSS-10 each with five alternative answers based on the Symptom's frequency. The final ranges of Perceived Stress level varies from 0-40. Higher score indicates higher stress level. The questionnaire (Portuguese version) used has very good internal consistency (17)

2.5.1 Repetitive Stress Injury

For the prevalence of repetitive stress injury (MSD symptoms), the Nordic General Questionnaire (NGQ) was used. It includes all the body regions with yes or no responses to the MSD symptoms in the various body regions during the last one year and last one week (Table-3)

The data was collected from the selected shoe companies. Questionnaire was distributed to the workers and they took about 30 minutes in filling. It has been

found that there is high prevalence of MSD symptoms in hand and fingers in the last one week and one year. It may be due to the manual skills and various human oriented tasks involved in the manufacturing of shoes.

Other body part such as shoulder, neck and low back, Ankle/foot etc. have MSDs due to maintaining postures for long duration. Postures may be standing or sitting. Awkward postures and repetitive jobs in shoe manufacturing.

2.6 Analysis

The association between MSD symptoms and level of perceived stress was evaluated by the Chi-square test for trends with .05 as significance level. The Scores of Perceived Stress were distributed in four different ranges. 0-9 was Low, 10-19 was moderate, 20-29 High and 30 or higher was very high.

Table 4: Association between presence of MSD symptoms and levels of perceived stress in the last one year and one week

| SN | PSS-10 | Total No. | MSD Symptoms in workers in the last one year with 95% CI | | | MSD Symptoms in workers in the last one week with 95% CI | | |
|----|------------|-----------|--|-------|------------|--|------|------------|
| | | | % | OR | CI | % | OR | CI |
| 1 | 0-9 | 46 | 46 | 1.0 | 0.81-0.90 | 24.2 | .32 | 0.30-0.34 |
| 2 | 10-19 | 128 | 54.8 | 1.19 | 1.18-1.25 | 29.3 | .41 | 0.40-0.43 |
| 3 | 20-29 | 84 | 66.7 | 2.02 | 1.94-2.07 | 38.7 | .63 | 0.61-0.65 |
| 4 | 30 or more | 09 | 92.9 | 13.04 | 6.44-56.39 | 64.8 | 1.84 | 1.47-10.31 |

Table 5: Association between presence of MSD symptoms and levels of perceived stress in the upper limbs in the last one year and one week

| SN | PSS-10 | Total No. | MSD Symptoms in Upper Limbs of workers in the last one year with 95% CI | | | MSD Symptoms in upper Limb in the last one week with 95% CI | | |
|----|------------|-----------|---|------|-----------|---|-------|-----------|
| | | | % | OR | CI | % | OR | CI |
| 1 | 0-9 | 46 | 21.2 | 0.27 | 0.26-0.28 | 17.5 | 0.21 | 0.30-0.34 |
| 2 | 10-19 | 128 | 35.8 | 0.56 | 0.54-0.57 | 15.2 | 0.180 | 0.40-0.42 |
| 3 | 20-29 | 84 | 54.3 | 1.19 | 1.15-1.23 | 19.9 | 0.25 | 0.61-0.65 |
| 4 | 30 or more | 09 | 60.1 | 1.50 | 1.20-1.89 | 49.9 | 1.00 | 1.47-2.31 |

Table 6: Association between presence of MSD symptoms and levels of perceived stress in the Lower Limb in the last one year and one week

| SN | PSS-10 | Total No. | MSD Symptoms in Lower Limbs of workers in the last one year with 95% CI | | | MSD Symptoms in Lower Limb in the last one week with 95% CI | | |
|----|------------|-----------|---|------|-----------|---|------|-----------|
| | | | % | OR | CI | % | OR | CI |
| 1 | 0-9 | 46 | 21.6 | 0.28 | 0.26-3.78 | 13.8 | 0.16 | 5.04-0.17 |
| 2 | 10-19 | 128 | 33.7 | 0.51 | 0.49-1.07 | 12.9 | 0.15 | 1.07-0.15 |
| 3 | 20-29 | 84 | 50.8 | 1.03 | 1.00-6.26 | 23.4 | 0.31 | 1.65-0.32 |
| 4 | 30 or more | 09 | 69.3 | 2.26 | 1.80-1.15 | 42.8 | 0.75 | 1.39-0.94 |

Table 7: Association between presence of MSD symptoms and levels of perceived stress in workers spine in the last one year and one week

| SN | PSS-10 | Total No. | MSD Symptoms in the spine of workers in the last one year with 95% CI | | | MSD Symptoms in the workers spine in the last one week with 95% CI | | |
|----|------------|-----------|---|------|-----------|--|------|-----------|
| | | | % | OR | CI | % | OR | CI |
| 1 | 0-9 | 46 | 44.9 | 0.80 | 0.76-0.84 | 13.9 | 0.05 | 0.05-0.05 |
| 2 | 10-19 | 128 | 31.4 | 0.11 | 0.11-0.12 | 11.8 | 0.01 | 0.01-0.01 |
| 3 | 20-29 | 84 | 40.2 | 0.32 | 0.31-0.33 | 20.3 | 0.06 | 0.06-0.06 |
| 4 | 30 or more | 09 | 48.9 | 5.20 | 4.15-6.51 | 24.7 | 0.90 | 0.72-1.13 |

In the recent past, lot of importance has been given to relationship between physical problems and mental condition (18). Our results are showing that 79.7 percent of workers reported perceived stress between score of 10-30. This shows that most of Shoe manufacturing workers are suffering from stress levels ranging from moderate to high (20). The result of the study by Cohen and Janicki-Deverts (20) indicated high level of stress amongst unemployed workers. Absenteeism from the job is the basic cause of reduced productivity which may be due to higher levels of stress and Strain and an additional societal cost for the success of organization. (22, 23)

Stresses in the work can be the combination of low decision control and high demand. Along with this low societal support, low recognition, very low career opportunities,

low rewards and insecurity of job can also affect poorly to the health of workers and leads to various health related problems (21). In shoe manufacturing units, most of the above factors are present indicating higher stress rates and MSD symptoms observed in the current study.

3.0 Association between Perceived Stress and MSD symptoms:

It has been observed that the associations between perceived stress and MSD symptoms in the last one week was more powerful than that of last one year indicating high level of stress and MSD symptoms.

The results of the present study showed a strong association of MSD symptoms in lower and the upper limbs with perceived stress in the last one year and one week.

Psychological strain may affect the wrist/hand and shoulder as per the hypothesis of the association of Perceived stress and MSD Symptoms. A strong association of our study was found between perceived stress and MSD symptoms in the lower limbs. The results of the study by Govindu and Babski (24) indicated that various psychosocial factors may increase tension in the muscles and may impact biomechanical load, resulting in to posture change and change in various forces exerted.

High popularity of symptoms in the spine in the different levels of perceived stress was observed indicating relationship of these symptoms with biomechanical factors such as maintain long sitting or standing posture. It was suggested by Zemp et.al. (25), that for maintaining the spinal health, dynamic posture is more important whereas static sitting increases the risk of back pain. Results of the previous studies are indicating an association of perceived stress and pain in knee, low back, shoulder and forearm etc. (26, 27). Results of the present study resemble to the large extent with the previous studies (29). Decreased work performance and ability of doing work were found to be associated with musculoskeletal pain along with the stress due to long standing. (28). In the recent studies, it has been found that presence of MSD symptoms along with the perceived stress has a tendency to increase the risk of unsuitability for work. (28)

4.0 RESULTS

It has been found that one year MSD symptoms among the participant workers (266) was 67% (n= 178) and were associated significantly with perceived stress (OR=13.95% CI: 6.44-56.39). One week prevalence of MSD symptoms was 33% and were also associated significantly with perceived stress (OR: 1.84, 95% CI: 1.47-10.31). The association between MSD and perceived stress indicates a strong

association between MSD and perceived stress level.

As a result we found that there is high association of MSD systems in lower and upper limbs and perceived stress among the shoe manufacturing workers. Hence, Stress, workplace risk factors and MSD should be considered in designing the policies for promotion of health in shoe manufacturing workers.

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