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Abstract - Musculoskeletal disorders (MSDs) are common health problem throughout the world and a major cause of disability in the workplace. This study was conducted among workers of a small scale forging Industries. The small scale forging units involve various kinds of high repetitive processes like Blanking, cutting, shearing, furnace loading, hammering, punching and trimming etc. the workers performing these type of activities are suffering from various MSDs. In this study I had surveyed 10 small scales forging industries and randomly selected 102 workers among these industries. The most common ergonomics problems were found in industry like wrong working positions of the workers and manual material handling. MSDs are found due to Inappropriate and poor working postures, lack of task variation, poor ergonomic design of work places, poor design of plant layout, long working hours, low salaries and awkward schedules are all areas where relatively simple intervention can Significantly reduce the rate of exposure to MSDs.

Keywords: *Musculoskeletal disorders, men, forging industry.*

I. INTRODUCTION

Work-related musculoskeletal disorders (MSDs) are impairments of body structures such as muscles, joints, tendons, ligaments, nerves, bones or a localized blood circulation system caused or aggravated primarily by the performance of work and by the effects of the immediate environment where the work is carried out. Most work related MSDs are cumulative disorders, resulting from repeated exposures to high- or low-intensity loads over a long period of time. There has been an increasing effort in recent years to investigate the causes of musculoskeletal disorders (MSDs) and to take action to prevent them. This has led to increasing recognition from workers, employers and government agencies that a strong relationship exists between factors within the working environment and the development of MSDs, and that these conditions result in significant sickness absence and reduced productivity [1] WMSDs are one of the biggest occupational health problems in industrialized countries (Hagberg et al., 1995)[2]A number of occupational factors have been identified as being associated with musculoskeletal disorders. The main contributing factor for musculoskeletal disorders is poor working posture (Burdorf et al., 1991) [3], which can result in minor back problems to severe handicap (Åaras et al., 1988)[4]. WMSDS are more common in women than 5 in men but as of yet the special needs of female workers are not met (Battenvi et al., 1998; Zetterberg and Öfverholm, 1999) [5][6]. Epidemiological data concerning work-related musculoskeletal disorders are usually available in industrially developed countries, especially in the Nordic countries. According to the Swedish Work Environment Authority (SWEA) (2005) [7], any existing disorder, physical or non-physical, which employees relate to their work is classified as a work-related disorder. According to the report's preliminary figures on reported occupational accidents about 118,523 occupational accidents (employed and self-employed) were reported in the year 2004(SWEA 2005) [8]. The focus on physical workload affects widespread occurrence of their exposure among the several working population. In a large European survey from 1991, (45%) of the 130 million workers in European Union (EU) were exposed to either manual material handling (lifting, carrying) repetitive movements or awkward work postures. According to United states (US) Bureau of labor statics, 32% of all the cases of occupational disorder (N=705800) are due to overexertion or repetitive movements (HSE,2005)[9]. A study conducted in an Iranian communication company showed significant association between job tenure and reported MSDs in knees & upper back (p less than 0.05) such that with increasing job tenure, the prevalence rate of problems in these regions increased, it also showed a significant association between RULA risk level and prevalence rate of reported MSDs in lower back. Another study among the aging male steel workers shows that prior acute injuries are potential risk factor

for MSDs in the workplace (Won-Jun Choi et al, 2009)[10]. Ergonomics defines itself as a science which aids in the designing of the task, tools and work environment to suit the capabilities of the workforce (Hager,2003)[11], whereby it involves matching the task to the worker, rather than attempting to fit the worker to the task/job (Owen, 2000)[12]. The same author reiterates that the goal of ergonomics is to identify aspects of the job which are hazardous and to then assess and redesign them to be safer for the individual. This will also result in a reduction in the occurrence of musculoskeletal disorders (MSDs) and contribute to the improvement of occupational health (Bernard, 1997; Buckle and Devereux, 1999; Jafry and O'Neill, 2000) [13][14][15]. Many occupational accidents, injuries, diseases and MSDs continue to arise due to a lack of ergonomics in the workplace, and there is a need to quantitatively assess exposure of individuals to MSDs. An estimated hundred million occupational injuries are occurring annually throughout the world (Leigh *et al.*, 1999; Dzissah *et al.*, 2001)[16][17], with compensation for these injuries and illnesses sustained by workers under occupational conditions imposing a large financial burden. This is occurring in industrialized and developing nations, including South Africa (Keyserling, 2000a, 2000b)[18][19], with the United States for example having compensation costs estimated at 20 billion dollars (Kelsey *et al.*, 1979)[20]. Despite attempts at making the alleviation of risks more effective, MSDs continue to be the most common form of work-related ill-health in the workplace. This highlights the importance of instituting effective solutions to curb the rise in expenditure in relation to occupational illnesses, injuries and MSDs(Amell *et al.*, 2002[21].

II. MATERIAL AND METHODOLOGY

The study was done in small scale forging units in Ludhiana and Jalandhar Region. A video of different sections like forging, punching, Trimming Furnace, broaching and grinding etc. showing different movements of the workers during an activity was recorded. The results of present case study could be an appropriate base for planning and implementing interventional ergonomics programmes in the workplace and improving worker's health in these small scale forging units. The Objectives of the study is to identify issues and problems associated with MSDs activities and possible solutions for that and assessment of the level of workers exposure to MSDs risk factors. It is believed that the results of this study could be an appropriate base for planning and implementing interventional programmes in the workplace and improving worker's health in these small scale forging units. The Output variables are obtained by the analysis of different input variables. After analyzing the input variables with the help of chi-square test we can get the output variables.

Input variables

There are following input variables in this case studies.

1) Nature of job: In this study the workers were categorized according to their nature of job such as Blanking, cutting, shearing, furnace loading, hammering, trimming and punching, Grinding and drilling, Broaching, Chamfering, heat treatment and inspection, Welding and Lathe with this data we will be able to get the association between the prevalence of MSDs and nature of job.

2) Age of the workers: A sample size of 102 workers was selected, so we divided in three age groups i.e. Up to 30 years, 31-45 years and above 45 years.

3) Body mass index of workers: To get the association between the height, weight and risk of MSDs, we categorized the data according to the body mass index (BMI).

BMI=wt. in kg/(ht. in m) 2 the different BMI groups were Up to 20, 20-25, Above 25 (kg/m2).

4) Marital status: To get the association between the prevalence of musculoskeletal disorders among the married and unmarried workers. Workers were categorized according to their marital status i.e. whether he is married or unmarried.

5) Experience of workers: This is the critical variable for the prevalence of MSDs among workers if working hours (including overtime) are more then there are more chances of the prevalence of MSDs another variable is the job tenure i.e. worker is doing the job from how many years.

6) Drug Addiction: Data was collected from the workers about their personal habits like; alcoholism, smoking and tobacco intake and its association with prevalence of MSDs

7) Qualification of workers: The workers were categorized according to their Qualification such as illiterate, (1 to 5th std.), (6 to 10th std.), above 10th. As Education plays a vital role in increasing the level of thinking and the workers will be able to aware about their health.

8) Rest time: The workers were categorized according to their rest time taken such as (Up to 30mins), (31 to 45mins), and (Above 45mins) and its association with prevalence of MSDs

9) Pain in body parts: Data was collected from the workers about their work related musculoskeletal

disorder like shoulder, neck, Upper Arm, Lower Arm, Wrist, Back and legs etc.

10) Risk of injury in specific body parts. Data was collected from the workers about the risk of injury in specific body parts like Arms, Back, Eyes, Fingers, Hands, Legs, Neck, Shoulders and Wrist etc while doing particular job.

11) Routine of work: Data regarding the routine work of workers is obtained with the help of questionnaire whether the worker is performing his duty while sitting, standing, walking, bending or lifting heavy loads. These types of activities are categorized according to never, sometime, often, always.

Output variables:

Output variables are the variables obtained by the analysis of different input variables with chi-square methods, output variables are the criteria to conclude. After analyzing the input variables with the chi-square test we can get the following output variables.

3.1.16. Chi-square values.

Chi-square values can be obtained with the help formula χ 2 = (O-E) 2/ E where (O) = observed frequency (E) = expected frequency in the corresponding category with degree of freedom v =(r- 1) (c-1) where (r) and (c) are the number of columns and rows respectively. If this chi square value (χ2) is equal to or greater than the table value (Table-1) then reject the null hypothesis if this value is less than the table value then it can probably say that any difference is due to chance alone. The Null hypothesis can be accepted or rejected with 5% level of significance i.e. (value of' p' less than 0.05). The values of chi square shown in Table-1.

Degree of Freedom (v)	Probability α				
	.10	.05	.025	.01	.005
1	2.71	3.84	5.02	6.63	7.88
2	4.61	5.99	7.38	9.21	10.6
3	6.25	7.81	9.35	11.3	12.8
4	7.78	9.49	11.1	13.3	14.9
5	9.24	11.1	12.8	15.1	16.7
6	10.6	12.6	14.4	16.8	18.5
7	12.0	14.1	16.0	18.5	20.3
8	13.4	15.5	17.5	20.1	22.0
9	14.7	16.9	19.0	21.7	23.6
10	16.0	18.3	20.5	23.2	25.2

3.2 Methodology proposed

In the proposed methodology for risk assessment of MSDs among the workers of small scale forging industries is discuss below.

3.2.1 Workers

The present cross-sectional study included randomly selected 102 workers from small scale forging industries of Punjab. Oral consent was received from these workers who volunteered for the study. The workers were performing different jobs in various sections like blanking, cutting, shearing, hammering, punching and Trimming, grinding, furnace loading etc. Around 95% of these workers were performing their jobs manually except a few material handling.

3.2.2 Questionnaire study

The questionnaire included demographic descriptors, Table-1 Values of chi-square the nature of job / process, experience (in years) , working hours, over time, personal information of the worker regarding work posture, physical load, smoking, alcohol and tobacco intake, Risk of injury and MSDs in specific body parts. Questionnaire was constructed and applied to the full sample.

III. RESULTS

After collecting the data from the questionnaire which give the demographic data, information regarding physical activity or addiction habits, this data was then entered in an excel sheet, from which the following results have been obtained.

1) Nature of job performed by workers and prevalence of MSDs: There is nine sections in which the workers were performing their tasks shown in Table-2. The majority of workers informed MSDs from blanking, cutting and shearing section, furnace loading section, punching and trimming section, picking and placing section. The results regarding the nature of job performed by workers and prevalence of MSDs are shown by the Table-2

Nature of job workers	No. of Workers Informed MSDs	No. of workers informed No MSDs
Blanking, cutting, and shearing	6	6
Furnace loading	8	7
Hammering	4	11
Punching and Trimming	7	6
Grinding and Drilling	5	9
Broaching,Chamfering and Heat treatment	2	2
Inspection	2	2
Picking and placing	8	10
Lathe and Welding	4	3

Table- 2 Nature of job performed by worker sand prevalence of MSDs

From the Table-2 calculated χ^2 value = $\Sigma (O - E)^2 / E$ = 3.97 and from (Table-1) with degree of freedom 8 value of χ^2 = 15.5 Because calculated value of χ^2 is less than (Table-1) value hence we accept the null hypothesis so there is no significant association between prevalence of MSDs and nature of job performed by the workers ($p< 0.05$).

2) Age of workers and prevalence of MSDs: After analyzing demographic data we get the data regarding age of workers, the mean age is 34.75 yrs. The results regarding the age of workers and prevalence of MSDs are shown by the Table-3.

Age of workers	No. of workers informed MSDs	No. of workers informed No MSDs
Up to 30	12	38
31 to 45	7	16
Above 45	15	4

Table -3 Ages of workers and prevalence of MSDs

From the Table-3 the calculated χ^2 value = $\Sigma (O - E)^2 / E$ = 18.34 and from (Table-1) with degree of freedom 2 is χ^2 = 5.99. Because calculated value of χ^2 is more than the (Table-1) value hence we reject the null hypothesis so there is a significant association between prevalence of MSDs and age of workers ($p< 0.05$), it shows that the workers having more age are under higher risk of MSDs.

3) Body mass index and prevalence of MSDs among the workers: After analyzing the data regarding the body mass index and prevalence of MSDs is shown in the Table-4.

BMI of workers	No. of workers informed MSDs	No. of workers informed No MSDs
Up to 20	17	22
20 to 25	22	29
Above 25	7	5

Table -4 Body mass index and prevalence of MSDs

From the data of (Table-4) calculated χ^2 value = $\Sigma (O - E)^2 / E$ = 0.99 and from (Table-1) with degree of freedom 2 is 5.99. Because calculated value of χ^2 is less than the (Table-1) value hence we accept the null hypothesis so there is no significant association between prevalence of MSDs and Body mass index of workers ($p< 0.05$).

4) Marital status of workers and prevalence of MSDs: Majority of the workers are married 68% workers are married and only 32% workers are unmarried as shown in the Table-5.

Marital status	No. of workers informed MSDs	No. of workers informed No MSDs
Married	40	30
Unmarried	6	26

Table- 5 Marital status of workers and prevalence of MSDs

From Table-5 calculated χ^2 value = $\Sigma (O - E)^2 / E$ = 13.08 and from (Table-1) with degree of freedom 1 value of χ^2 = 3.84. Because calculated value of χ^2 is more than the (Table-1) value hence we reject the null hypothesis so there significant association between prevalence of MSDs and marital status of workers ($p< 0.05$). It shows that the married workers are under higher risk of MSDs

5) Experience and prevalence of MSDs: Results from the data reveals that majority of the workers (58.8%) having experience of up to ten years, (21.5%) workers having 11 to 20 years, only (9.8%) of workers having experience 21 to 30 and Above 30 years. These findings are shown by the Table-6.

Experience of workers	No. of workers informed MSDs	No. of workers informed No MSDs
Up to 10	18	42
11 to 20	10	12
21 to 30	9	1
Above 30	9	1

Table – 6 Experience and prevalence of MSDs

From Table-6 calculated χ^2 value = $\Sigma (O - E)^2 / E$ = 21.81 and from (Table- 1) with degree of freedom 3 is χ^2 = 7.81 Because calculated value of χ^2 is more than the (Table-1) value hence we reject the null hypothesis so there is significant association between prevalence of MSDs and experience of job performed by the workers. It shows that the workers having less experience they are at higher risk of MSDs ($p< 0.05$).

6) Drug Addiction habits and prevalence of MSDs: Present study showed that 54 % subjects are using

alcohol, smoke, tobacco and 46% workers are not using a drugs. as shown in the Table- 7.

Drug addicted	No. of workers informed MSDs	No. of workers informed No MSDs
Alcohol	11	6
Smoke	10	7
Tobacco	15	22

Table -7 Addiction habits and prevalence of MSDs

From the Table-7 the calculated χ^2 value = $\Sigma (O - E)^2 / E$ = 14.18 and from (Table-1) with degree of freedom 2 is 5.99. Because calculated value of χ^2 is more than the (Table-1) value hence we reject the null hypothesis so there is a significant association between prevalence of MSDs and drug addiction habits of workers ($p< 0.05$).

7) Qualification of workers and prevalence of MSDs: Data reveals that 37.2% workers are illiterate, 21.5% remaining are very less educated 1to 5^{th} std., 34.31% are less educated 6 to 10^{th} std, and only 6.8% workers are educated. Table- 7 and fig: 7 show the results of Qualification of workers and prevalence of MSDs as Shown in Table-8.

Qualification of workers	No. of workers informed MSDs	No. of workers informed No MSDs
illiterate	21	17
1 to 5th	8	14
6 to 10th	16	19
Above 10th	1	6

Table -8 Qualification of workers and prevalence of MSDs

From Table-8 the calculated χ^2 value = $\Sigma (O - E)^2 / E$ = 79.65 and from (Table-1) with degree of freedom 3 is χ^2 = 7.81. Because calculated value of χ^2 is more than the (Table-1) value hence we reject the null hypothesis so there is significant association between prevalence of MSDs and Qualification of workers ($p< 0.05$). It shows that the workers are illiterate or very less educated under higher risk of MSDs.

8) Rest time of worker and prevalence of MSDs: Data regarding the rest time and prevalence of MSDs is shown in Table-9.

Rest time in (min)	No. of workers Informed MSDs	No. of workers Informed No MSDs
Up to 30	16	20
31 to 45	9	4
Above 45	21	32

Table -9 Rest times of workers and prevalence of MSDs

From Table-9 calculated χ^2 value = $\Sigma (O - E)^2 / E$ = 8.97 and from (Table-1) with degree of freedom 2 is χ^2 = 5.99 Because calculated value of χ^2 is more than the (Table-1) value hence we reject the null hypothesis so there is significant association between prevalence of MSDs and rest-time performed by the workers ($p < 0.05$).

9) Overtime per week and prevalence of MSDs: In these small scale industries the overtime per week is not having much value, majority of the workers are having overtime up to 12 hours per week (44%). (23.5%) workers are having overtime 13 to 18 hours per week and 22.5% workers are having overtime Above 18 hours per week. Data regarding the overtime and prevalence of MSDs is shown in Table-10.

Over time per week in Hours	No. of workers informed MSDs	No. of workers informed No MSDs
Up to 12	26	29
13 to 18	9	15
Above 18	11	12

Table -10 Overtime per week and prevalence of MSDs

From Table-10 calculated χ^2 value = $\Sigma (O - E)^2 / E$ = 0.73 and from (Table-1) with degree of freedom 2 is χ^2 = 5.99 Because calculated value of χ^2 is less than the (Table-1) value hence we accept the null hypothesis so there is no significant association between prevalence of MSDs and over-time performed by the workers ($p < 0.05$).

10) Workers with pain in specific body parts: Available data as shown in Table-11 and fig: 1 reveals that 19.6% of workers are suffering from shoulder pain,

31.3% from neck pain, 8.8% from upper Arm pain, 5.8% from lower Arm pain, 7.8% from wrist pain, 4.9% from leg pain and majority of workers are suffering from back pain that is 49%. Data regarding pain in specific body parts is shown in Table-11.

Pain in specific body parts	No. of workers Informed MSDs
Shoulder	20
Neck	32
Upper Arm	9
Lower Arm	6
Wrist	8
Back	50
Legs	5

Table -11 Workers with pain in specific body parts

11) Routine work activities: In the routine activities that the workers were exposed to lifting heavy load, majority of the workers were performing their task in bending posture. These types of working conditions are responsible for occurrence of MSDs among the workers. The activities of workers are categorized such as Sit, Stand, Walk, Bend and Lifting heavy loads, the results of the activities of workers are shown in Table-12.

Routine work	Never	Sometime	Often	Always
Sitting	50	13	18	21
Standing	14	30	12	46
Walking	13	80	9	0
Bending	5	55	41	1
Lift Heavy load	65	16	12	9

Table -12 Routine work activities of workers

12) Risk of injury in specific body parts and prevalence of MSDs: In routine work, shoulders, neck, hand and back are the workers' body parts which are prone to maximum risk of injury. This risk goes up to 90 % as per available data shown in Table-12.

Risk of injury in specific body part	No. of workers Informed risk MSDs
Arm	4
Back	45
Eyes	1
Fingers	1
Hand	13
Leg	1
Neck	15
Shoulder	19
Wrist	3

Table -12 Risk of injury in specific body parts

IV. DISCUSSION

After visiting the various Industries and collecting the data I came to know that there is great Muscular Disorder (MSD) in the bodies of the workers. Muscular Disorder is calculated by using Chi-square method by various categories. By the considering nature of job the like shearing, blanking and picking-placing maximum MSD occurs. Further considering the age of the selected workers MSD occurs more in the workers aged more than 45, less in workers aged 35 to 40. further less for below 35. Then considering martial status of the workers it has been observed that maximum MSD occurs in the married workers as compared to the single ones. It has been observed during calculations that when experience is taken in account inexperienced workers are much more prone to MSD as compared to the experienced workers. When it comes to the drug addiction of the workers it has been observed that person taking tobacco is having more MSD as compared to the person taking alcohol or smoking. Another point is that the worker which is less educated has MSD because the awareness in the less educated workers is also less. Due to continuous working and less rest period given the worker is subjected to High Muscular Disorder and nevertheless overtime per week is also main cause of MSD. Workers having specific pain in their bodies are also effected by MSD cause they are not fully fit to perform there job but the do it intentionally which causes muscular pain. It also seen that MSD also depends upon the routine activities of the worker as the kind of operation is being performed like bending, lifting of heavy loads and continuous standing for long durations which causes muscular pain in the neck and back etc. it has been observed that there is a Risk of

injuries in the specific parts of the bodies of the worker due to working like back, neck, arms and legs. There is urgent need of improvement in the working environment of the workers in order to improve the efficiency of the worker so as to create best working conditions.

V. CONCLUSSION

It was concluded that Muscular Disorder occurs in almost every small scale industries and workers are subjected to high risk of MSD. The questionnaire showed the symptoms of MSD were in every worker studied shoulder, back wrist/hand and knees were found to be most prevalent problems among the workers. There is an urgent need of corrective measures to be taken. Study of ergonomics and its implementation is required as soon as possible to provide proper work stations and healthy and comfortable working conditions to obtain maximum production with proper utilizations of resources.

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