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(Full length research article)

Gender Differences in Prevalence of Ergonomic Stressors and Upper Extremities Musculoskeletal Problems in Sugar Industry Workers

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Abstract

Nowadays, occupational accidents are one of the most important problems in developing countries. Ergonomic stressors have been recognized as an effective factor in increasing the risk of musculoskeletal problems among industry workers. So, the main goal of this study was to evaluate the Ergonomic stressors and UE musculoskeletal problems and their associations with the genders. The study was performed on 225 blue collar sugar industry workers. Physical and psychosocial stresses of work, job diagnostics, hazards of workplace, working environment and MSDs prevalence were assessed. The data for this research was obtained by ergonomics checklist using Likert's scale. Results of the statistical analysis indicated that working posture (OR 4.6, p<0.05), Exhaustion and workload (OR 3, p<0.05), job duration >10 yr (OR 3.6, p<0.05), manual material handling (OR 2.8, p<0.05) were the main cause of musculoskeletal problems among the workers. Male workers were more prone to the developing pain in the neck (OR 2.7; p<0.001) in comparison female workers were more prone of developing pain in upper back (OR 1.9; p<0.05) and shoulder (OR 1.8; p<0.05). Correlation analysis indicated that a significant relationship exist between the work aspects and musculoskeletal problems and were the result of the ergonomic stressors. It was concluded from the study that ergonomic stressors should be recognized as an important factor causing UE musculoskeletal problems and differed significantly between male and female workers.

Keywords: *Ergonomic stressors, gender differences, musculoskeletal problems, work aspects, Likert's scale*

1. Introduction

India has 566 sugar mills in the country, of which 56 per cent are in the co-operative sector, 34 per cent in the private sector and the remaining 10 per cent are in the public sector. India ranks second, next to Brazil in terms of area (4 million hectare) and sugar production (about 26.4 million tonnes). The Indian sugar industry comprises about 20 per cent of sugar mills and 15 percent of sugar production of the world. It is the second largest agro-processing industry in the country, with total employed capital of Rs. 50000 crores and an annual turnover of Rs. 25000 crores. It plays a key role in rural development by creating direct employment to 5 lakh skilled and unskilled workers. In this industry, physical activities such as manual material handling (e.g., heavy load lifting, lowering, carrying, pulling, and pushing) and awkward working postures are very common. The production process is very labor intensive and workers are exposed to work related musculoskeletal disorders (MSDs) risk factors. In this situation, a high rate of occupational accidents is expected which should be taken care of.

Today, occupational accidents are considered among the potential threats because of their serious humanitarian, economic, social, and environmental consequences [6]. Occupational accidents and injuries are the third cause of mortality in world. Musculoskeletal disorders (MSDs) are one of the most important problems ergonomists encounter in the workplace around the world [22]. According to International Labor Organization (ILO) report in 1999 the average estimated fatal occupational accident rate was 14.0/100000 workers and the number of fatal accidents was 335000 [20]. MSDs affect a large proportion of the working population and their quality of life and contribute to increasing healthcare costs, lost work days and higher social insurance expenditures in most welfare states. For example, the annual costs of employee stress, including costs for missed wages due to absenteeism and reduced productivity and health care costs, have been estimated to be $200-350 billion in the United States, $64.8-66.1 billion in the United Kingdom, and $232 billion in Japan [11]. MSDs affect the muscles, tendons, ligaments, and

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joints of the human body. They are the cause of common complaints in both the general and working populations. In 1990, 15% of the entire working population in the USA suffered from one or more types of chronic MSDs, and this rate is anticipated to increase to 18% within the next 30 years [10]. It was identified in an Iranian sugar industry that most workers (87.1%) suffered from some kind of MSD symptoms. Awkward postures, manual material handling, and long hours of standing were the major ergonomics problems [2].

Ergonomic stressors such as physical and psychological stressors are responsible for the various types of MSDs. Stressors are repetitive machine paced tasks, various postural stresses, and forceful exertions, segmental vibration exposures, contact mechanical stresses, organizational constraints, interpersonal conflict, role conflict, role ambiguity, workload, work hours, job insecurity lack of reward and lack of control. These factors cause a fall in concentration and the ability of decision making, and an increase in absent-mindedness, poor memory, and doubtfulness in people that lead to do unsafe acts of employees [16]. Several studies have also proved that stress has played a role in 37% of the accidents and injuries in industry [7]. In spite of apparently similar occupational pattern of work, gender differences do exist in the prevalence and severity of MSDs and perception of work as stressors. Employee health and well-being have gained increasing societal attention, driven by both rising worker compensation claims and the considerable personal, organizational, and medical costs associated with stress-related illness [18]. Therefore, the present study was carried out with the objectives of (a) examine the different dimensions of ergonomic stressors among the Daurala (UP) sugar industry workers (b) explores its association with the prevalence of musculoskeletal problems among male and female workers and (c) existence of any gender difference.

2. Methods

A total of 225 blue collar Daurala Sugar industry workers were finally included in the study after excluding 53 workers for the reasons shown in table 1. The workers were divided into two groups males (N=149), Females (N=76). Keeping in mind the linguistic problem, the questionnaire was explained to the workers in local language by the interviewer. Most of these workers belong to the lower economic status, carrying heavy loads for a small financial gain, ignoring their physical capabilities and possible health risks.

2.1 The survey

The study was conducted by introducing interviewer-administered questionnaires. The prevalence of self-reported MSDs among the workers was evaluated using NIOSH checklist [3]. The worker's responses regarding severity of pain in the last two years, work-day lost due to pain, their perception on the causation of pain and the remedial measures taken to mitigate pain were recorded.

Table 1 Participation in the study

	Male		Female	
	N	%	N	%
Invited Subjects	186	-	92	-
Reasons of no participation				
Not available during the survey	13	7	4	4.3
Previous MSDs	6	3.2	3	3.3
poor responses	9	4.8	5	5.4
Reason unknown	9	4.8	4	4.3
Participating subjects	149	80.2	76	82.7

Severity of pain was scored on the scale of mild, moderate, severe and unbearable (1–4) and loss of productivity was measured in terms of loss of working days and restricted duties. Informed consent was obtained from each participant before the starting of study.

To identify the aspects of work and stressors, the workers were interviewed by a multi-method ergonomic checklist [15]. The ergonomics checkpoints (Appendix 1) pertaining to this study include the enquiry on work system analysis, such as job characteristics, physical and psychosocial stresses of work, job diagnostic dimensions, constraints of workplace and tools, and hazards of physical environment. The checklist entries were responded by a single digit on a five-point Likert's scale where strong disagreement to the statement (1) to strong agreement to the statement (5), were scored. The low value is the positive indicator of the perception of absence of the stress. The relative loading of scores for each section of the checkpoints was arrived at from the ratio of the summated score value to that of maximum cumulative scores possible under that section. The values greater than mid value of maximum possible score were considered as the positive indicator of the stressors. In other words, for each of the work stressors, the relative loadings would range within 0 to 1 and the loading of each aspect of work equal to or more than 0.5 was considered as a stressor.

2.2 Statistical analysis

Data analysis was performed using SPSS statistical software, version 17.0. The descriptive statistics, including prevalence percentage and the odd ratios of the test measures were obtained with reference to work

groups, personal characteristics, physiological and psychosocial stressors. The normality of data was checked by K-S Test and the distribution of the data for most variables was found to be normal ($p<0.05$). Multivariate analysis was done using binary logistic regression model with backward elimination method in order to understand the work stressors and worker characteristics on the occurrence of MSDs. The relationship of the ergonomic stressors to MSDs was examined by Pearson correlation. The reliability co-efficients for internal consistencies (Cronobach's alpha) of the ergonomics checklists were examined and alpha value ranged from 0.682 to 0.838 indicating moderate to adequate reliability.

3. Results

Mean age and job tenure of male workers were significantly higher ($p<0.001$) than those of female workers (Table 2). Male workers spend longer working hours per day to those of female workers. Males were also more literate in comparison of females.

Table 2 Personal characteristics of the workers

Characteristics	Male (n=149)	Female (n=76)
Age (yr.)	42.5±8.4	31.3±9.4
Job tenure (yr.)	18.6±7.2	11.4±6.4
Working hours/day	11.3±2.7	10.4±3.1
Literacy (%)	79	74

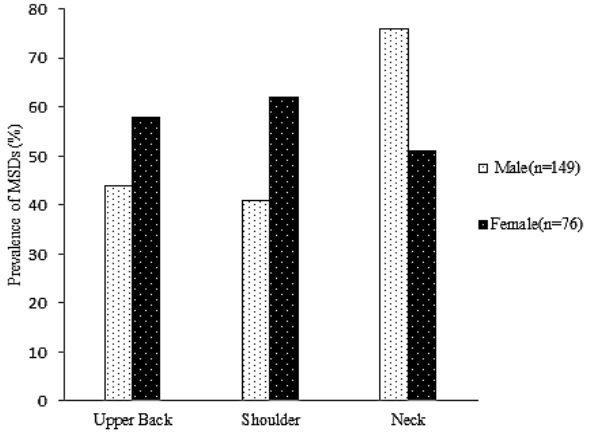

Fig. 1 Prevalence of MSDs among male and female workers in Sugar industry

3.1 Prevalence of MSDs among workers

About 84% males and 76% females reported work related MSDs (Fig. 1). Male workers were more prone to the developing pain in the neck (OR 2.7; CI (1.4–6.2); $p<0.001$) in comparison female workers were more prone of developing pain in upper back (OR 1.9; CI 1.2–3.8; $p<0.05$) and shoulder (OR 1.8; CI (1.6–3.8); $p<0.05$). Males and females having age >25 yr ($p<0.05$), and working hours >8h ($p<0.05$) had significant influence on the occurrence of MSDs (Table 3). Females having job tenure >10 yr ($p<0.05$) had also significant influence on the occurrence of MSDs. Males (OR 3.2; $p<0.05$) had greater loss of productivity in terms of loss of working days. The workers had mixed responses about their perception to the cause of pain and discomfort and were generally indifferent to remedial measures (Table 4).

3.2 Psychosocial variables and MSDs

Nearly two-third of the workers (55–62%; $p<0.05$) had complaints of general chronic fatigue ($p<0.05$). About 49% males (OR 4.2) and 48% females (OR 1.3) had poor job satisfaction, with positive association to developing MSDs in any of the three body regions (Table 5). About 62% males had anxiety problem (OR 3.8; $p<0.05$) and had positive effect on MSDs occurrence. Mental overload had significant effect on the occurrence of MSDs among male (OR 7.4; $p<0.05$) and females (OR 4.3; $p<0.05$) workers. Inadequate social support had no significant impact on MSDs among workers.

3.3 Work aspects and MSDs

The use of ergonomics checklists led to elucidation of multiple aspects of work of the workers. Responses of the workers to the ergonomic stressors as a function of gender are shown in Figs. 2. Male workers identified skill acquisition ($p<0.05$), Task situation ($p<0.001$), Manual material handling ($P<0.05$), work posture ($p<0.001$), noisy workplace ($p<0.01$), work schedules ($p<0.001$), mental overload ($p<0.001$), work methods and tools ($p<0.001$) as more stressful, as compared to the responses of the female workers, who identified demand of job specialization ($p<0.001$), workplace designs ($p<0.01$), work environment ($p<0.001$) as significantly stressful. Multivariate analysis indicated that job experience <10 yr (OR 2.5, $p<0.05$), high mental overload (OR 3.7, $p<0.001$), poor working environment (OR 9.1. $p<0.05$), literacy (OR 3.86, $p<0.05$), contributed to the occurrence of pain among the workers. Correlation coefficient was calculated among the ergonomic stressors and the occurrence of MSDs and the statistically significant ones are marked (Table 6). It was analysed that ergonomics stressors are responsible for different kind of MSDs

Table 3 Personal characteristics and their association with MSDs as indicated by risk estimate

	Male			Female		
	OR	95%CI	p	OR	95%CI	p
Age >25yr (compared against ≤25yr)	2.4	1.3-4.6	0.04	2.8	1.3-6.7	0.03
Working hours >8h (compared against ≤8h)	1.4	1.2-1.6	0.7	1.1	1.2-3.4	0.04
Marital status (married compared against non-married)	0.5	0.7-3.8	0.8	0.2	0.6-8.9	0.8
Job tenure >10yr (compared against ≤10yr)	2.6	0.8-11.6	0.4	3.6	1.3-4.4	0.03
Literacy: Literate (compared against illitrate)	1.6	0.8-5.4	0.4	2.4	0.7-8.4	0.7

OR = Odd Ratio, 95%CI = 95% Confidence Interval

Table 4 Severity of pain, remedial measures and causes of MSDs as reported by the workers

	Male	female	OR	95%CI	p
Pain severity (%)					
Severe pain	25	16	1.7	0.8-3.2	NS
Mild pain	52	44	1.6	0.8-2.9	NS
Productivity loss	21	8	3.2	1-8.2	0.01
Worker's perception to the cause of pain (%)					
Posture	18	7	4.6	1.5-16.6	0.01
Work equipment	21	18	1.6	0.8-3.2	NS
Work method	31	17	1.6	0.8-2.8	NS
Exhaustion and work load	29	6	3	1.8-7	0.02
Personal reasons and others	7	8	2.4	0.9-6.4	NS
Worker's selection of remedial measures (%)					
Pain killer oral medicine (self-medication)	12	16	0.7	1.4-2.4	NS
Medical aid (consult doctor)	21	17	0.9	0.6-1.9	NS
Balm massage	8	22	0.6	0.5-1.4	NS
Hot water foot bath	11	13	1.1	0.5-2.4	NS
Rest	8	7	1.8	0.6-5.8	NS
No remedial measures	58	64	1.1	0.5-1.6	NS

OR= Odd Ratio, 95%CI= 95% Confidence Interval, NS= Not Significant

Table 5 Psychosocial-variables and their association with MSDs as indicated by risk estimate

	Male				Female			
	%	OR	95%CI	p	%	OR	95%CI	p
Chronic Fatigue	56	4.6	1.6-10.4	0.02	61	2.1	1.3-6.3	0.04
Job dissatisfaction	49	4.2	1.1-12.7	0.01	48	1.3	0.2-6.7	0.6
Anxiety	62	3.8	1.4-13.4	0.03	57	1	0.6-3.1	0.7
Job autonomy	81	1.2	0.4-3.1	0.7	72	1	0.4-4.3	0.4
Job feedback	80	1.4	0.3-3.7	0.7	87	1.3	0.2-3.8	0.6
Task clarity	65	1.1	0.5-2.5	0.08	72	2.1	0.7-3.9	0.4
Mental overload	65	7.4	2.3-17.6	0.001	46	4.3	1.2-11.6	0.03
Inadequate social support	36	2.7	0.7-8.9	0.3	32	2.6	0.3-7.6	0.7

OR = Odd Ratio, 95%CI = 95% Confidence Interval

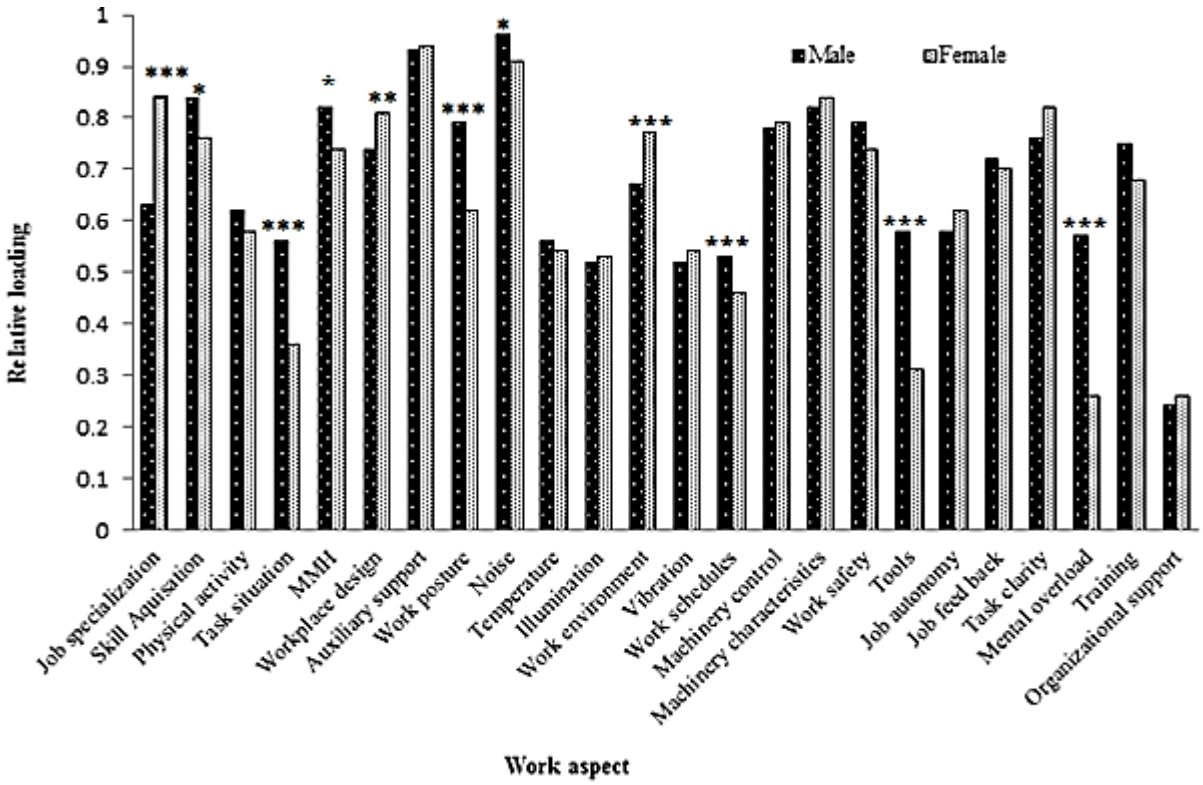

Fig. 2 Responses of male and female workers in Sugar industry (*p<0.05; **p<0.01; ***p<0.001)

Table 6 Relationship (Correlation) between work aspects and MSDs

	Male			Female		
	Upper back	Shoulder	Neck	Upper back	Shoulder	Neck
Skill requirement			■		O	
Manual material handling	O	■				
Task situation						
Workplace design			O			
Auxiliary support	O	■				O
Strenuous work posture						
Hot environment	■				O	■
Noise at workplace						
Less illumination						
Work environment	O	O				O
Work schedules						
Machine characteristics						
Machinery control				O		
Tool mismatch						
Work safety				◊		
Poor job autonomy	O					O
Poor job feedback						
Task clarity			■			
Mental overload				O	■	

Correlation Coefficients O p<0.05, ■ p<0.01, ◊ p<0.001

3. Discussion

In India, most of the sugarcane cultivation is concentrated in the sub-tropical zone (Uttar Pradesh, Uttarakhand, Bihar, Punjab, and Haryana) that accounts for 67 per cent of the area and 62 per cent of the production. Uttar Pradesh is the largest sugarcane producing State in India. During 2002-03, 111 sugar mills were in operation and crushed 64.51 million tonnes of sugarcane which was almost 50 per cent of the total production of the country. Over 50 percent of these mills are in the private sector and the remaining mills are in the other sectors. The study on Daurala (UP) sugar industry workers showed a self-reported prevalence of MSDs among the male and female workers due to multi-dimensional work stressors. By the statistical analysis it was found that different ergonomic stressors are responsible for the prevalence of MSDs among the workers. The study showed a real gender difference in the way male and female sugar industry workers respond to the work stressors. There is also some evidence that psychosocial variables are relevant in the difference between male and female [14].

Work-related musculoskeletal disorders (WMSDs) have emerged as major health problem among workers in both industrialized and industrially developing countries [13, 23]. Study reveals that human factor is the main cause of accidents [Heinrich, 1959]. Most researchers believe that unsafe behaviors are the key agent for more than 70% of occupational accidents [4]. In addition to lack of necessary skills, inherent characteristics, incorrect beliefs, and attitudes, one of the most important causes of unsafe behaviors is high occupational stresses [15]. Study reported on Iranian sugar industry workers confirms the prevalence of MSDs [2]. In the present study about 78 % of male workers had the neck pain in contrast 58% and 62% of female had the upper back and shoulder pain respectively. The workers who perceived their work to be monotonous or boring were at an increased risk of developing shoulder pain [8]. The reasons of high prevalence of these MSDs among the sugar industry workers are the awkward work postures, lifting heavy loads, and carrying the load for a long distance. The study observed that long working hours (>8 h) and long job duration (>10 yr) had positive impact on the occurrence of MSDs among women as observed in the previous study [5]. Long working hours deteriorate both physical and mental health [1, 19, 21].

About the 67% of women had only primary level of education and remaining were illiterate this made them vulnerable to psychosocial stress, in terms of exploitation, less bargain power for wages [12]. Psychosocial stressors are associated with musculoskeletal problems [9]. Correlation analysis showed significant relationship of dimensions of work aspects (Table 6) with pain and discomfort, substantiating that the work related MSDs are the results of interaction of multiple stressors associated with work and work environment, and other personal factors. Differences in Prevalence of MSDs among male and female workers call for attention, that the intervention strategies must be developed considering the gender differences amongst the workers in sugar industries. Gender differences in the prevalence and occupational consequences of musculoskeletal disorders (MSDs) are consistently found in epidemiological studies. Today, occupational accidents are considered among the potential threats because of their serious humanitarian, economic, social, and environmental consequences [6]. Employee health and well-being have gained increasing societal attention, driven by both rising worker compensation claims and the considerable personal, organizational, and medical costs associated with stress-related illness [18]. The Journal of Occupational and Environmental Medicine says that workers who report high levels of stress have health care expenditures nearly 50 percent higher than other workers [17]. Ergonomic stressors should be recognized as an important factor causing occupational injuries among sugar industry workers.

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Appendix 1 Details of ergonomics checklist

Work aspects	Details
Job specialization	Specific job, production volume, quality of work and multiple task
Skill requirement	Training, knowledge, skill required for job, frequent mistakes at work, job rotation and machine paced work
Physical work/ activity	Target oriented pace, repetitive movements, muscular exertion and working position
MMH	Load handling mode, load weight, distance, height, etc.
Task situation	Material loading, handle position, unsafe practices and mechanical aids
Workplace design	Work distance away from normal reach, poor clearance space, presence of obstacles
Auxiliary support	Storage space, restricted passage, design mismatches of staircases, awkward positioning of limbs for hand foot hold, poor supports
Work posture	Arm stretch, wrist extension, neck/shoulder angle, bent and twisted, one sided body movement
Noise	Noise at work area, absence of sound isolation and emergence measures.
Climate	Temperature, humidity, ventilation device at workplace
Lighting	Illumination intensity, presence of shadows, etc.
Work environment	Presence of dust, poor ventilation, Monitoring of the workplace for chemical toxicants, absence of protective measures
Vibration	Continuous exposure and possibility to eliminate or isolate
Work schedule	Working at night and overtime, uneven distribution of work tasks, incorporation of work rest and working at a predetermined pace
Machinery control	Awkward positioning, mismatched dimensions with body parts, force, speed and precision required in operation, and unpleasant feelings while operation
Machine characteristics	Maintenance, high noise level and poor visibility of machine due to dust
Tools	Using with alternate hands, weight, handle form and position
Work safety	Removal and fastening of accessories, poor positioning, contact with body parts, difficult to inspect and lack of instruction for safe operation
Job autonomy	Time schedules, absence of assistance and insufficient people for assistance of work, rigid method of work
Task clarity	Unambiguous goal, job restrictiveness, work conflict, boredom, poor scope
Mental overload	High workload, repetitive act, superficial attention, multiple choice and simple motor act
Training	Advancement to higher levels, lack of opportunities, poor training and incentives
Organizational commitment	Organizational role, medical services, control absenteeism, labour inspection and monitoring

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