Impact of Ergonomic Training in work-related Musculoskeletal Pain and posture among Sugar Factory Workers: Quasi-experimental Study

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Abstract

WMSDs are defined as "multifactorial when the environment and the performance of work contribute significantly, but as one of the numbers of factors the causation of disease".[1]Many occupational activities and work tasks are done by workers which can lead to musculoskeletal disorders partially caused by adverse work condition.`[2]They can be exacerbated by workplace exposures, and they can impair work capacity.[3] WMSDs include clinical syndromes such as tendon inflammations and related conditions such as tenosynovitis, epicondylitis, bursitis, nerve compression disorders, carpal tunnel syndrome, sciatica, and osteoarthrosis, as well as standardized conditions such as myalgia, low back pain and other regional pain syndromes not attributable to known pathology. Body regions most commonly involved are the low back, neck, shoulder, forearm, and hand, although recently the lower extremity has received more attention.[4]

Upper extremity musculoskeletal disorders are also highly prevalent in manual intensive occupations, such as clerical work, postal service, cleaning, industrial inspection, and packaging.[5]Back and lower limb disorders occur disproportionately among truck drivers, warehouse workers, airplane baggage handlers, construction trades, nurses, nursing aides and other patient-care workers and operators of cranes and other large vehicles.[6]

Previous studies done on the Indian population of farmers and household workers estimated an annual incidence of occupational disease between 924,700 and 1,902,300 and 121,000 deaths in India. Descriptive studies on basic risk factors for the development of WMSDs are mechanical overload, repetition frequency, exposure time, posture, and accidents.

WMSDs occur due to physical work requirements and individual factors determine muscle force and lengths a function of times which determine muscle energy requirements, in turn, can lead to fatigue when can lead to muscle disorders.[7,8]

Long-maintained static posture impairs proper tissue nutrition and blocks the necessary oxygen inflow to muscles. As a result of permanent muscle tension, they become stiff and painful. Typical examples of awkward posture include reaching behind, twisting, working, overhead, wrist bending, kneeling, stooping, forward and backward bending, and squatting.[9]

In sugar-producing factories, workers are directly involved in the production process. 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. In this situation, a high rate of WMSDs is expected. The production process is very labor intensive and workers are exposed to WMSD risk factors. According to the workers' medical records around 22.75% of all occupational illnesses were related to the musculoskeletal system. As far very less ergonomic interventional studies were been conducted in the sugar-producing industry to determine the prevalence of WMSDs and to assess physical exposure to work-related musculoskeletal risks.[10,11]

In Maharashtra, the sugarcane industry is quite evenly and widely spread. In rural areas at the sugar industrial workplace, the level of risk includes the extent of exposure to hazards. The working and living conditions of the sugar industry workers are extremely poor. The occupational health problems in workers working in various processing units of the sugar industry are enormous mainly because of a variety of occupational stress factors. Little attention has been paid to occupational stresses in sugar industry workers.[11]In sugarcane factories the workers are exposed to large quantities of liquid, fumes, and gases that may be given off at various stages of the refining process. The commonest injuries occurring at the worksite are heatstroke, various kinds of dermatitis, conjunctivitis, deafness, falls, and burns. The incidences of dental decay are fairly high. Tuberculosis and chronic fatigue are distinctive in tropical countries and these are diseases that are peculiar to the area.[11,12]Sugar industry workers working in all the sections have to perform various types of jobs rotation of valves of types of machinery at various sections, baling of biogases, lifting carrying in sugar house and storage house involves movement of the body in an awkward posture.[13]

The workers from the storage section of the sugar industry are continuously engaged in lifting and carrying heavy bags of sugar working without any personal protective equipment.

Ergonomics is concerned with making the workplace as efficient, safe, and comfortable as possible. Effective application of ergonomics in work system design can achieve a balance between worker characteristics and task demands.[14]

The features of the ergonomic design of machines, workstations, and facilities are well known. The main concern of work system design is usually the improvement of machines and tools. Therefore, poorly designed work systems are commonplace in the industry. Neglect of ergonomic principles brings inefficiency and pain to the workforce. An ergonomically deficient workplace can cause physical and emotional stress, low productivity, and poor quality of work.

METHODS

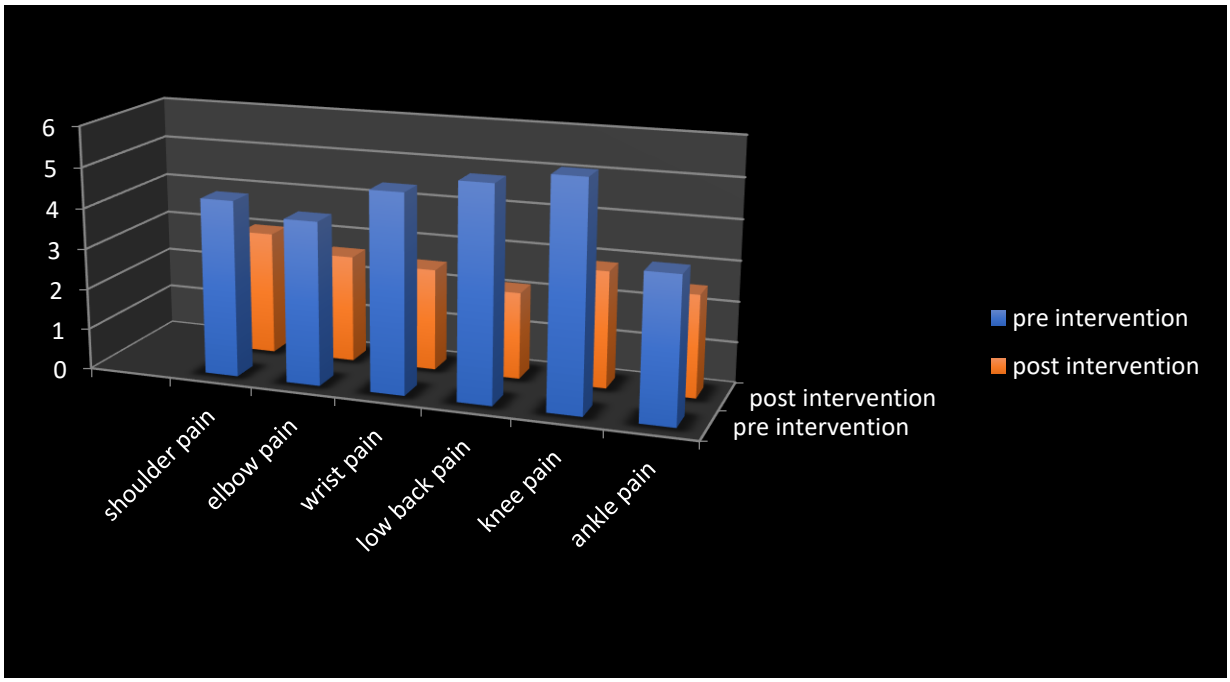
The study was conducted among the participants from Dr. Vitthalrao Eknathrao Vikhe Patil Pravara Sahkari Sakar Kharkhana, pravaranagar. The study received ethical approval from the Institute Ethical committee (MPT12016108). The sample size for this study was 30. The study variables like work-related musculoskeletal pain were assessed by NPRS and working posture was assessed by the OWAS method. Post-intervention scores were measured after 3 weeks of ergonomic training. The work-related musculoskeletal pain was measured by the Numerical pain rating scale (NPRS) and working posture was evaluated with the help of the ovako working posture analysis system (OWAS). Prior to the assessment, we explained the scale to the participants, what is the scale about and what purpose we are using the scale, the significance of this scale.

Coding system:

1) Normal posture – No intervention required (Code 1)
2) Slightly harmful- Correction action should be taken during the next regular review work method(code2)
3) Distinctly harmful-Correction action should be taken as soon as possible(code3)
4) Extremely harmful- Correction action should be taken immediately(code4)

ERGONOMIC TRAINING - In ergonomic training, basic principles of ergonomics were taught to workers during the basic informative session, conducted in a sugar factory. In ergonomic training, basic exercises were taught. Basic stretching exercises were also included in ergonomic training. Along with the training, job modifications were given to workers in the form of material handling techniques, techniques of weight lifting, where the load is to be placed, the number of people required to perform the lifts, clearing the work area of hazards and obstructions.

NPRS		Mean	Std. Deviation S.D	t value	Mean difference	p value
Neck pain	Pre-intervention	4.33	1.88	-4.910	1.3	P < 0.001 (S)
	Post-intervention	3.03	1.82			
Shoulder pain	Pre-intervention	4	1.66	-4.274	1.36	P < 0.001 (S)
	Post-intervention	2.63	1.56			
Elbow pain	Pre-intervention	4.86	1.43	-4.699	2.36	P < 0.001 (S)
	Post-intervention	2.5	1.22			
Wrist pain	Pre-intervention	3.66	1.64	-4.465	1.56	P < 0.001 (S)
	Post-intervention	2.1	0.99			
Low back pain	Pre-intervention	5.23	1.59	-4.812	3.1	P < 0.001 (S)
	Post-intervention	2.13	1.04			
Knee pain	Pre-intervention	5.53	1.77	-4.578	2.66	P < 0.001 (S)
	Post-intervention	2.86	1.16			
Ankle pain	Pre-intervention	3.53	1.35	-4.916	1.03	P < 0.001 (S)
	Post-intervention	2.5	1.25			



DISCUSSION

The result of the study showed that the ergonomic intervention was effective in terms of reduction in pain in the sugar factory workers and some working postures were appropriate for working and some postures needs correction with the help of modified workplace designs and education for the sugar factory workers about the ergonomics and how to apply during working in the factory. The frequency of musculoskeletal pain was found to be reduced in workers receiving the ergonomic intervention along with workplace training and significant improvement in working posture. The result was highly significant for ergonomic intervention ($p<0.001$). For pain, the pre-intervention scores on NPRS for neck pain in participants were 4.33±1.88. The post-intervention values were 3.03±1.82 the mean difference between pre and post-intervention NPRS scores was 1.3. On comparing the pre and post-intervention values of NPRS in participants with ergonomic intervention, it was observed that the difference was highly significant ($p<0.001$). The pre-intervention scores for NPRS in shoulder pain in participants were 4±1.66. The post-intervention values were 2.63±1.56 the mean difference between pre and post-intervention NPRS scores was 1.36. On comparing the pre-and post-intervention values of NPRS in a participant with ergonomic intervention, it was observed that the difference was highly significant ($p<0.001$).

The pre-intervention values for NPRS in elbow pain in the participants were 4.86±1.43 the post-intervention scores were 2.5±1.22 the mean difference between pre and post-intervention NPRS scores was 2.36. On comparing the pre-and post-intervention values of NPRS in a participant with ergonomic intervention, it was observed that the difference was highly significant ($p<0.001$). The pre-intervention scores for NPRS in wrist pain for the participants were 3.66±1.64The post-intervention scores were 2.1±0.99 the mean difference between pre-and post-on NPRS scores was 1.56. On comparing the pre-and post-intervention values of NPRS in a participant with ergonomic intervention, it was observed that the difference was highly significant ($p<0.001$). The pre-intervention scores for NPRS in low back pain in the participants were 5.23±1.59. The post-intervention scores were 2.13±1.04 the mean difference between pre-and post-intervention on NPRS scores was 3.1. On comparing the pre and post-intervention values of NPRS in participants with ergonomic intervention, it was observed that the difference was highly significant ($p<0.00$ 1). The pre-intervention scores for NPRS in knee pain for the participant who received the ergonomic intervention were 5.53±1.77. The post-intervention scores were 2.86±the mean difference of pre and post-on NPRS scores was 2.66. On comparing the pre and post-intervention values of NPRS in participants with ergonomic intervention, it was observed that the difference was highly significant ($p<0.001$). The pre-intervention scores for NPRS in ankle pain for the participant who received the ergonomic intervention were 3.53±1.35. The post-intervention values were 2.5±1.25 the mean difference between pre- and post-intervention NPRS scores was 1.03. On comparing the pre-and post-intervention values of NPRS in a participant with ergonomic intervention, it was observed that the difference was highly significant ($p<0.001$).

The distribution of action categories among trunk postures using the OWAS method. The action category 1(code1) pre-score was 26.6% and the post-score was 33.33%. The action category 2(code2) pre-score was 23.3% and the post-score was 40%. The action category 3(code3) pre-score was 23.3% and the post-score was 10%.

The action category 4(code4) pre-score was 26.6% and the post-score was 16.66%. The distribution of action category among upper extremity using OWAS method. The action category 1(code1) pre score was of 33.3% and the post score was 50%. The action category 2(code2) pre-score was 36.6% and the post-score was 33.33%. The action category 3(code3) pre-score was of 30% and the post-score was 16.33%. The distribution of action category among lower extremity using OWAS method. The action category 1(code1) pre-score was 26.6% and the post-score was 36.66%. The action category 2(code2) pre-score was 20% and the post score was33.33%. The action category 3(code3) pre-score was of 30% and the post score was aws16.66%. The action category (code4) pre-score was 26.6% and the post-score was 13.33%. In was a significant difference in pre and post-scores in OF OWAS.

Ergonomic intervention in the form of workplace exercises and activity modification, and job modification was useful in correcting working posture. There was a significant improvement in action category 3(code3) and action category 4 (code 4) working posture among the trunk, upper limb, and lower limb respectively. Amir Houshang Mehrparvaret al compared the effects of ergonomic workplace exercises and stretching exercises on musculoskeletal complaints, the ergonomic modification consisted of correcting the arrangement of the workstation and changing some equipment workplace exercises included stretching exercises focusing on the neck, shoulders, low back, and hand and wrist. Musculoskeletal complaints were assessed and compared before and after 1-month interventions. The frequency of musculoskeletal complaints was high before the intervention. Both interventions significantly reduced complaints in a similar manner except for low back pain which was reduced in the exercise group more than in the other group. In this study, we found a beneficial short-term effect for both ergonomic modifications and Stretching workplace exercises on reducing musculoskeletal pain in office workers.[31, 52]

Another study showed that Posture analysis by OWAS method in 97 workstations in the Sourak tobacco factory showed that 30.9% of body postures were normal, 37.1% of body postures were stressful, 26.8% of body postures were harmful and 5.1% of body postures were very harmful. Owas posture analysis in 20 welders of the oil industry performed by Soltani in 2010 showed that 58.5% of welders were in a normal posture, 34.7% were in a stressful posture, 4% were in a harmful posture and 2.5% were in a very harmful posture. In another similar study performed by Habibi in the Mahyaman factory in Isfahan, 72.2% of the workers were in a normal posture, 21.2% in a stressful posture, 2.7% in a harmful posture, and 3.5% in a very harmful posture. Comparing these results to our investigation shows that the workers of the Sourak tobacco factory are at higher risk for developing musculoskeletal disorders. According to our results, ergonomic interventional programs seem to be necessary. We recommend providing and use of ergonomic chairs, frequent rests, modification in manual material handling, workers' education as well as engineering controls.[3253]In a study by Choobineh et al. on the staff working in an oil refinery, educational interventions as well as improvement in the working environment such as purchasing ergonomic chairs, improving the existing seats, adjusting the height of keyboard and monitor according to the characteristics of each person and the use of wrist support for the administration staff were applied. Repeating these assessments six months after the start point of specific interventions application showed a significant reduction of musculoskeletal disorders in parts of the back, lower back, ankle, and foot in the intervention group compared to the control group.[54, 14]

In 2009 Tompa et al systematically reviewed ergonomics and other musculoskeletal injury prevention interventions with economic analyses. Their review identified only four medium-quality interventions in the healthcare sector published between 1990 and 2006. They concluded that there was moderate evidence that ergonomics and other musculoskeletal injury prevention interventions in the healthcare sector are worth undertaking for economic reasons. This paper provides an update of those findings, with an expanded assessment of the identified, evaluated intervention studies[55]in several studies that ergonomic modifications can decrease the frequency of musculoskeletal pain or discomfort among office workers. Amick et al assessed this effect after changing the chairs in an office environment and found considerable results they also found that training alone can also reduce the frequency of MSDs although to a level lower than ergonomic change; this result was also observed in the authors' previous study on office workers. Arnetz et al. found that workplace ergonomic intervention can decrease absenteeism among office workers although it has been shown in some studies that ergonomic modifications are significantly[55,52] effective for alleviating MSDs, they are costly, which is an important issue, especially in developing countries. Thus other interventions such as training, rest breaks, or workplace exercises are probably more practical in these countries.[56]

Conclusion

The result of this study shows ergonomic training is effective in reducing work-related musculoskeletal pain and working posture in sugar factory workers. This study also shows that because of awkward working posture workers are prone to musculoskeletal injuries affecting the economy and workers’ quality of life. Measure to reduce the incidence of musculoskeletal injuries considered in the study may help improve the worker’s efficiency, outcome, and job satisfaction.