



# THE EFFECT OF ERGONOMIC TRAINING VERSUS ERGONOMIC ADVICE ON MUSCULOSKELETAL PAIN AND FUNCTIONAL DISABILITY AMONG TYRE MANUFACTURING INDUSTRY WORKERS: A RANDOMIZED CLINICAL TRIAL

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## ABSTRACT

**Introduction:** Musculoskeletal disorders (MSDs) are a prevalent occupational health issue among workers in the tyre-building industry due to repetitive tasks, awkward postures, and prolonged working hours. Ergonomics plays a vital role in reducing MSD risk, yet the comparative impact of ergonomic training versus ergonomic advice remains underexplored.

**Aim:** To evaluate the effect of ergonomic training compared to ergonomic advice in reducing musculoskeletal pain and improving functional disability among tyre-building industry workers.

**Objective:** To assess and compare the impact of ergonomic training and ergonomic advice on musculoskeletal pain using the Visual Analogue Scale (VAS) and functional disability using the Disabilities of the Arm, Shoulder, and Hand (DASH) score over six weeks.

**Methodology:** A randomized clinical trial was conducted with a total sample size of 28 workers from the tyre-building industry. Participants were randomly assigned to either the ergonomic advice group (n=14) or the ergonomic training group (n=14). The ergonomic advice group was provided with written materials and brief consultations regarding ergonomic principles and practice. The ergonomic training group received a structured six-week program emphasizing practical ergonomic strategies and postural corrections. Outcome measures

included musculoskeletal pain (VAS) and functional disability (DASH), assessed at baseline and at the end of six weeks.

### **Result:**

The ergonomic training Group-B demonstrated significantly greater improvements compared to the ergonomic advice Group-A. The mean reduction in musculoskeletal pain (VAS score) was significantly higher in the Group-B (mean difference:  $1.93 \pm 0.27$ ) compared to the Group-A (mean difference:  $1.00 \pm 0.00$ ;  $p < 0.001$ ). Similarly, the Group-B showed a greater reduction in functional disability (DASH score) with a mean difference of  $17.36 \pm 1.11$  compared to  $9.57 \pm 3.61$  in the EAG group ( $p < 0.001$ ). The Mann-Whitney U test confirmed statistically significant differences in both outcomes between groups (VAS:  $U = 7.000$ ,  $p < 0.001$ ; DASH:  $U = 0.000$ ,  $p < 0.001$ ).

**Conclusion:** Ergonomic training is more effective than ergonomic advice in reducing musculoskeletal pain and improving functional disability among tyre-building industry workers. Implementing interactive ergonomic training programs in industrial settings is recommended to promote worker health and productivity.

**Keywords:** Ergonomic training, ergonomic advice, musculoskeletal pain, functional disability, tyre-building industry

**Abbreviation:** WMSDs – Work-Related Musculoskeletal disorders, VAS – Visual Analogue Scale, DASH – Disabilities of the Arm, Shoulder and Hand

### **ITNRDUCTION**

A large proportion of workers are employed by small-scale industries in developing nations as an alternative to automation. These industries significantly boost these nations' economies. Initiatives for employee health and safety are typically less thoughtful in these sectors.<sup>[1]</sup> In underdeveloped nations, there is a lack of awareness and implementation of control measures for occupational hazards.<sup>[2]</sup> Furthermore, workers in these nations who lack education are discouraged from adopting new technologies. Additionally, the workstations in the local manufacturing sector are badly built. Numerous Work-Related Musculoskeletal Disorders (WMSDs) are caused by workstations that are frequently not designed in accordance with ergonomic principles. Workers and industries around the world are greatly impacted by WMSDs.<sup>[3]</sup>

The phrase "impairments of bodily structures such as muscles, joints, tendons, ligaments, nerves, bones, or a localised blood circulation system that are caused or aggravated primarily by the performance of work and by the effects of the immediate environment where the work is carried out" is used to describe WRMSDs. The majority of WRMSDs are caused by cumulative high- or low-intensity loads over an extended period of time and recurrent exposure.<sup>[4-6]</sup> Therefore, it is well established that WRMSDs cause chronic occupational disabilities, decreased productivity, illness, absences, and a lower quality of life.<sup>[7]</sup> According to Esen et al., work-related variables account for 30% of MSDs worldwide. Static working postures, twisting motions, labour pace, force involved, monotony, vibrations, mental strains, and a lack of support are risk factors. These are further impacted by the loads

being handled and the design of the work area. [8,9] Even though tyre manufacturing companies have implemented sophisticated machinery with engineering controls, there are still risk factors for developing WRMSD. [10]

Risk factors that may have an impact on workers include longer manual handling tasks, repeated motions, heavier, larger, or unwidely loaded objects, and awkward or prolonged postures such bending, reaching, or twisting. [11] Work involving heavy lifting, pushing, or pulling, especially when it includes twisting or vibrating the spine, can cause severe discomfort and injury. The majority of industrial facilities and workplaces involve manual materials handling (MMH) tasks as pushing, pulling, lifting, lowering, and carrying. [12] In this industry, physical activities such as awkward posture tasks, repetitive motions, performing manual material handling tasks, and force exertions are very common. These risk factors may also place employees in uncomfortable circumstances. [13]

Ergonomics is the science that aims to make a workspace comfortable for humans in all of its physiological elements. [14] The Occupational Safety and Health Administration (OSHA) defines ergonomics as a link between people and their workplace that doesn't cause disruptions. In summary, ergonomics refers to the creation of a safe, comfortable, and healthy working environment for people. [15]

Physical problems like discomfort, muscle disorders, or musculoskeletal issues could result from a work attitude that is out of step with one's physical condition. A musculoskeletal disorder occurs when the muscles are overworked from repetitive and static actions that occur repeatedly over an extended period of time. This condition causes complaints of injury to the joints, ligaments, and tendons. Unnatural working postures brought on by task demands, tools, and work stations that are outside of employees' skills and limitations are the source of this. [16]

Employees who paid less attention to ergonomics (the state of the workspace arrangements) were primarily responsible for the majority of the workload effect outcomes. Human physical and mental limitations, which vary from person to person, are factors that must be taken into account when creating an ergonomics plan. Ignorance of these elements may have a detrimental effect on employees' health, leading to complaints as a sign of disease. [17]

## **MATERIALS AND METHODS**

This experimental study received approval from the Institutional Ethical Committee of Parul University. The study included 28 workers from a tyre manufacturing industry, aged 18-65 years, experiencing musculoskeletal discomfort. Inclusion criteria included individuals with a minimum of six months of employment in the tyre manufacturing industry and self-reported musculoskeletal pain. Exclusion criteria were participants with acute injuries, previous surgeries related to the musculoskeletal system, or any systemic illness that could affect musculoskeletal health.

Participants were randomly allocated into two groups (Group A and Group B) using a simple random sampling method. Before being randomly allocated to either the control and experimental group each participant were given complete information about the study protocol and given the informed consent. The outcome measures used were the Visual Analogue Scale to assess the intensity of musculoskeletal pain and Disabilities of the Arm, Shoulder, and Hand (DASH) Questionnaire to evaluate functional disability. Group A (n=14) were provided with written materials and brief consultations regarding ergonomic principles and practices. The advice focused on basic

workplace ergonomics, correct postures, and simple preventive measures to minimize musculoskeletal strain, and Group B (n=14) underwent a structured six-week ergonomic training program. The program includes, Education sessions on ergonomic principles and workplace risk factors, practical training in postural corrections and body mechanics specific to tyre manufacturing tasks, individualized feedback and reinforcement of ergonomic strategies during work activities.

### STATISTICAL ANALYSIS

Statistical analysis was done by using SPSS software version 27. It used a paired t-test to compare the pre and post parameters (VAS and DASH) for Group A and Group B. On the other hand, the unpaired t-test was used to compare the parameters after the intervention within each group. Microsoft Excel version 2021 has been used to create the table and graphic depiction.

### RESULT

28 individuals were recruited for the study and divided into two equal groups of 14 each. Pre- and post-Mean were calculated. Both groups showed significant reduction in VAS and DASH score but group B shows significantly greater reductions in both VAS and DASH scores compared to group A.

TABLE 1

PRE-POST COMPARISON OF VAS VALUE OF GROUP- A			
Group-A	Mean	SD	p-value
Pre	6.9286	0.82874	0.000
Post	5.9286	0.82874	

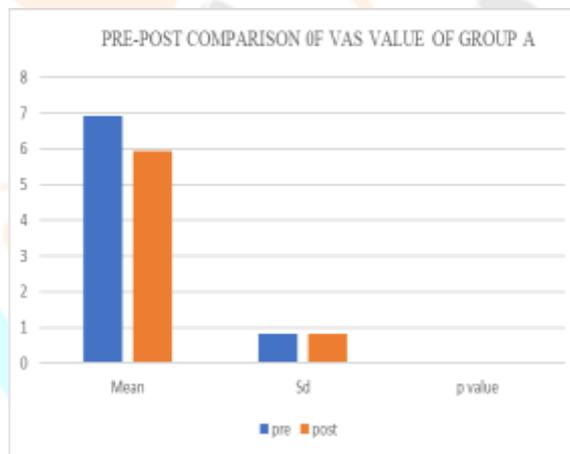
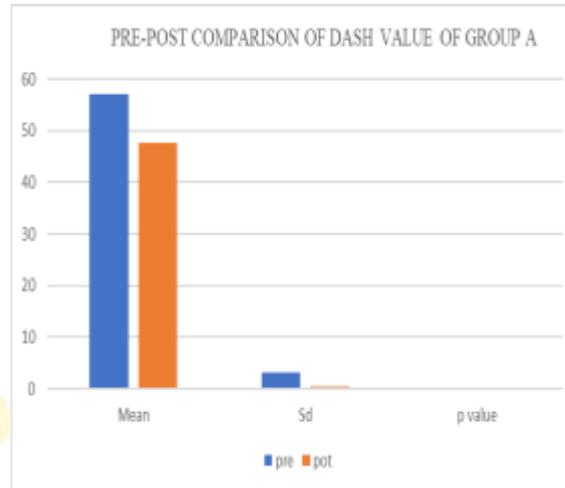


Table 1: shows the comparison of VAS in group A with pre- and post-mean  $\pm$ SD values of  $6.9286 \pm 0.82874$ , and post  $5.9286 \pm 0.82874$  respectively. Values are significant at  $p < 0.000$ .

**TABLE 2**

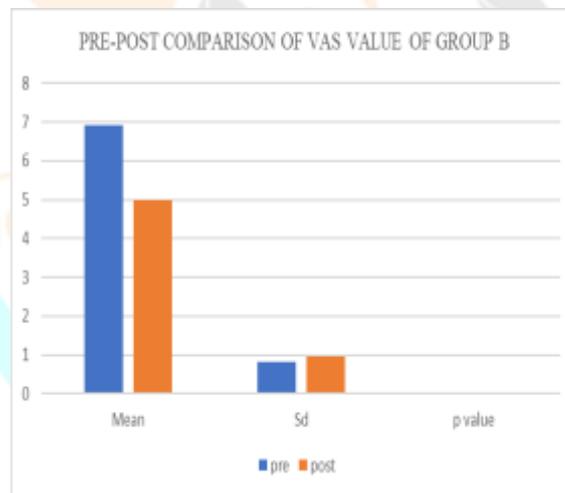
<b>PRE-POST COMPARISON OF DASH VALUE OF GROUP- A</b>			
<b>Group-A</b>	<b>Mean</b>	<b>±SD</b>	<b>p-value</b>
<b>Pre</b>	<b>57.1304</b>	<b>3.23651</b>	<b>.001</b>
<b>Post</b>	<b>47.5571</b>	<b>0.43095</b>	



TABEL 2: Shows the comparison of DASH in group A with pre- and post- mean±SD values of 57.1304±3.23651, and post 47.5571±0.43095 respectively. Values are significant at p<.001

**TABLE 3**

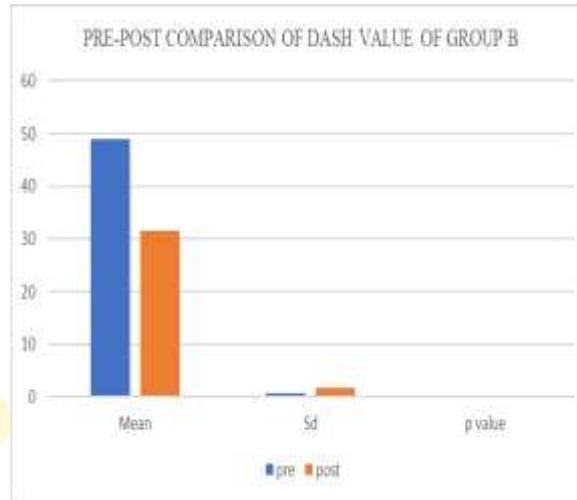
<b>PRE-POST COMPARISON OF VAS VALUE OF GROUP- B</b>			
<b>Group-B</b>	<b>Mean</b>	<b>±SD</b>	<b>p-value</b>
<b>pre</b>	<b>6.9286</b>	<b>0.82874</b>	<b>0.000</b>
<b>post</b>	<b>5</b>	<b>0.96077</b>	



TABEL 3: Shows the comparison of VAS in group B with pre- and post- mean±SD values of 6.9286±0.82874, and post 5±0.96077 respectively. Values are significant at p<0.000

**TABLE 4**

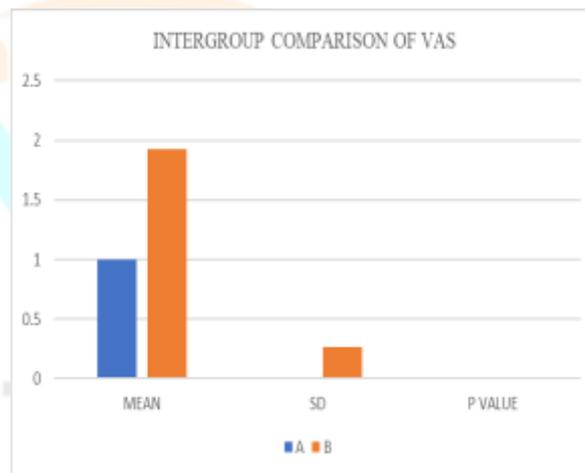
<b>PRE-POST COMPARISON OF DASH VALUE OF GROUP- B</b>			
<b>Group-A</b>	<b>Mean</b>	<b>±SD</b>	<b>p-value</b>
<b>Pre</b>	<b>48.875</b>	<b>0.75575</b>	<b>.001</b>
<b>Post</b>	<b>31.5111</b>	<b>1.69377</b>	



TABEL 4: Shows the comparison of DASH in group B with pre- and post-mean ±SD values of 48.875±0.75575, and post 31.5111±1.69377 respectively. Values are significant at p<.001

**TABLE 5**

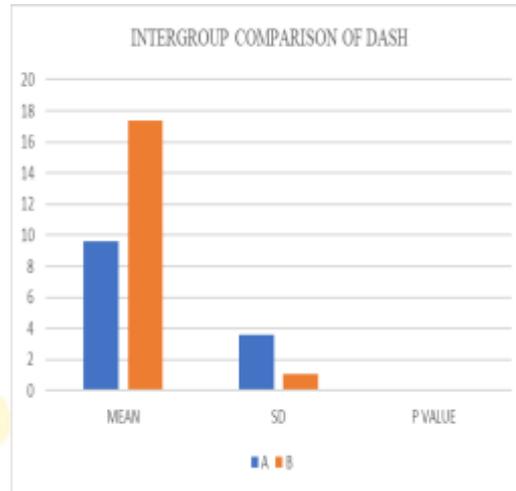
<b>INTERGROUP COMPARISON OF VAS</b>			
<b>Group</b>	<b>Mean</b>	<b>±SD</b>	<b>p-value</b>
<b>A</b>	<b>1.00</b>	<b>.000</b>	<b>0.000</b>
<b>B</b>	<b>1.9286</b>	<b>.26726</b>	



TABEL 5: Shows the comparison of VAS for group A and group B the pre-post mean ±SD values are 1.00±.000 and post 1.9286±.26726 respectively. Values are significant at p<0.000. The result showed more improvement in group B in comparison to Group A.

TABLE 6

INTERGROUP COMPARISON OF DASH			
Group	Mean	±SD	p-value
A	9.5732	3.61027	.000
B	17.3639	1.11015	



TABEL 6: Shows the comparison of DASH for group A and group B the pre-post mean  $\pm$ SD values are  $9.5732 \pm 3.61027$  and post  $17.3639 \pm 1.11015$  respectively. Values are significant at  $p < .000$ . The result showed more improvement in group B in comparison to Group A.

## DISCUSSION

The aim of the study was to evaluate the effect of ergonomic training compared to ergonomic advice in reducing musculoskeletal pain and improving functional disability. The study included 28 workers from a tyre manufacturing industry, aged 18-65 years, experiencing musculoskeletal discomfort according to the inclusion and exclusion criteria. Visual analogue scale (VAS) and Disability of Arm, Shoulder and Hand (DASH) were used as the outcome measure.

Loewenson (2002) stated that Various informal sector workplaces have poorly controlled work hazards, particularly welfare and hygiene, ergonomic and chemical hazards, worsened by poor work organisation, and poor community environments and social infrastructures.<sup>[2]</sup>

Sandul Yasobant (2014) stated that Work-related musculoskeletal disorders (WMSDs) are responsible for morbidity in many working populations and it reduces the quality of workers' life and the productivity.<sup>[7]</sup>

Ergonomic training and ergonomic advice both helped in reducing musculoskeletal pain and improving functional disability. So, the objective was to assess and compare the impact of ergonomic training and ergonomic advice on musculoskeletal pain using the Visual Analogue Scale (VAS) and functional disability using the Disabilities of the Arm, Shoulder, and Hand (DASH) score over six weeks.

Group A were provided with written materials and brief consultations regarding ergonomic principles and practices. The advice focused on basic workplace ergonomics, correct postures, and simple preventive measures to minimize musculoskeletal strain, and Group B

underwent a structured six-week ergonomic training program. The program includes, Education sessions on ergonomic principles and workplace risk factors, practical training in postural corrections and body mechanics specific to tyre manufacturing tasks, individualized feedback and reinforcement of ergonomic strategies during work activities.

In our study, there were significant changes in both groups. After 6 weeks Both groups showed significant reduction in VAS and DASH score but group B shows significantly greater reductions in both VAS and DASH scores compared to group A as it totally based on the body mechanics and ergonomics strategies

## CONCLUSION

As the result suggests that there was a significant reduction of pain and functional disability in the employees after the treatment. However, Group B who received 6-week ergonomic training program showed more improvement in pain and functional disability than Group A. Thus, it is concluded that ergonomics training program which includes Education sessions on ergonomic principles and workplace risk factors, practical training in postural corrections and body mechanics specific to tyre manufacturing tasks, individualized feedback and reinforcement of ergonomic strategies during work activities are useful in reduction of pain and functional disability

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## ACKNOWLEDGMENT

We express our deepest gratitude to everyone who contributed to the successful completion of this study.

Firstly, we sincerely thank Parul Institute and the Department of Physiotherapy for providing us with the necessary infrastructure and resources to conduct this research.

We extend our heartfelt appreciation to our guide, Dr Dharmang Vyas for their invaluable guidance, continuous encouragement, and insightful feedback throughout the course of this study. Their expertise and dedication have been instrumental in shaping this research.

We are immensely grateful to all the participants who willingly gave their time and effort to be part of this study. Their cooperation and commitment have been the foundation of this research.

Special thanks to our peers and colleagues for their moral support and constructive discussions, which enriched the quality of this work.

Lastly, we are indebted to our families for their unwavering support, patience, and motivation throughout this journey.

This study would not have been possible without the collective efforts of all those mentioned above. Thank you for your contribution and belief in our work.

