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Research Article

# The Effect of Physical Ergonomics Training on Sleep Quality and Musculoskeletal System Problems in Factory Workers

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**Abstract**

**Objective:** This study aimed to assess the impact of physical ergonomics training on sleep quality and musculoskeletal issues among factory workers.

**Methods:** Twenty-five factory employees aged 18-60, without neurological or emotional issues, participated. Data collection at baseline included a demographic form, the Pittsburgh Sleep Quality Index (PSQI), and the Cornell Musculoskeletal Discomfort Questionnaire. Following physical ergonomics training, these assessments were repeated after four weeks. Continuous data were analyzed using SPSS 29.0, with distribution differences tested by Kruskal-Wallis and Shapiro-Wilk methods. The Wilcoxon method determined any significant changes in non-normally distributed variables between initial and final measures.

**Results:** A significant improvement in PSQI scores (p=0.002) indicated enhanced sleep quality post-intervention. In the Cornell Musculoskeletal Discomfort data, a statistically significant reduction in neck pain was noted following training, while reductions in shoulder, back, and lumbar pain levels were not statistically significant. Although average score changes in the hip, upper and lower legs, knees, and feet suggested a trend in improvement, these differences were not statistically significant.

**Conclusion:** The findings suggest that physical ergonomics training could improve sleep quality and potentially reduce musculoskeletal discomfort among factory workers, highlighting its value for workplace health interventions.

**Keywords:** Pain, Ergonomics, Sleep Quality, Musculoskeletal Disorders

## 1. Introduction

Work-related Musculoskeletal Disorders (MSDs) are among the most common occupational diseases globally and have been recognized as a significant issue since the 17th century (1). MSDs are conditions affecting the musculoskeletal system, associated with physical dysfunction and pain (2). Factory workers exhibit a high prevalence of musculoskeletal disorders due to prolonged sitting, static postures, repetitive tasks, computer usage, and adverse environmental conditions (3).

Ergonomics is an interdisciplinary science aiming to optimize work environments and equipment to match human physical and mental capabilities. Originating from the Greek words "ergo" (work) and "nomos" (natural laws or systems), ergonomics emphasizes harmonizing work with human needs (4). Its primary objective is to enhance workplace safety and productivity while preserving worker health and comfort.

Differences in human physical characteristics hinder the suitability of uniform equipment or work arrangements for all employees. Non-ergonomic conditions in work environments can lead to severe health issues such as musculoskeletal disorders. For instance, poorly designed chairs or improper

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seating arrangements may result in prolonged abnormal postures, exacerbating neck, shoulder, back, and arm pain. Similarly, repetitive strenuous motions and the continuous use of small tools may cause conditions like carpal tunnel syndrome, particularly in the hands and wrists (5).

Implementing ergonomic principles in work environments is crucial for preventing health issues and enhancing productivity. Adjusting workspaces, equipment, and environmental conditions to ergonomic standards can reduce occupational injury risks and optimize employee performance. For example, using adjustable desks and chairs, positioning screens at eye level, and ensuring adequate lighting safeguard employees' health and positively impact business performance.

Among workers, MSD prevalence is reported as 28.2%-58.1% for the lower back, 22.9%-49% for the neck, 37.8%-41.5% for the upper back, and 18.8%-50.2% for shoulders (6, 7, 8). MSDs can negatively affect subjective sleep quality and cause sleep disorders due to persistent pain. Poor sleep quality may exacerbate MSDs, creating a vicious cycle of sleep disturbances and pain (9). Sleep disorders can also impair employees' mental and physical health, leading to increased anxiety or depression, reduced daytime functionality and quality of life, elevated workplace accidents, and decreased job performance (10).

Raising awareness among workers about ergonomic adjustments, proper posture habits, physical limitations, environmental adaptations, and early detection of issues is essential for preventing ergonomic-related injuries. Considering ergonomic features during the procurement of medical equipment plays a critical role in employee health and work efficiency.

MSDs impose a significant health burden on employees, reducing quality of life and disrupting sleep patterns. However, understanding and applying ergonomic principles effectively can prevent and improve existing MSDs and sleep disturbances (11, 12). Ergonomic approaches not only reduce health risks but also enhance physical and mental performance, fostering overall satisfaction and productivity in the workplace.

A direct link exists between the physical demands of work and MSDs. Factors such as age, body weight, physical fitness level, occupational factors, and job requirements play significant roles in the pathophysiology of MSDs (13). While these work-related disorders and sleep quality declines are preventable with ergonomic training, postural corrections, regular exercise programs, and frequent breaks, this study aimed to determine the effects of physical ergonomics training on sleep quality and MSDs in factory workers and evaluate the training's effectiveness.

## 2. Methods

This research was conducted using a single-group pretest/posttest quasi-experimental design.

### 2.1. Population and sample

The study was conducted with a sample group selected from individuals working in a construction materials factory. The study population consisted of 31 employees working in this factory. Participation in the study was based on voluntariness, and individuals aged between 18-60, cooperative, capable of communication, and without any neurological or emotional issues were included. Individuals with severe musculoskeletal disorders, cognitive or emotional problems, and those who engaged in regular exercise were excluded. From the population, 6 individuals who did not meet the inclusion criteria were excluded, and the study commenced with a total sample group of 25 individuals. A Post-Hoc Power analysis conducted after the study revealed an effect size of 0.83 and a power of 0.98. These results indicate that the sample size was sufficiently powered to detect statistically significant differences.

### 2.2. Data collection

Data were collected face-to-face from factory workers. Participants were informed by the researcher before inclusion, and those meeting the inclusion criteria participated. Participants completed survey forms within approximately 10 minutes through self-reporting. Evaluations were repeated four weeks after the Physical Ergonomics Training.

### 2.3. Data collection tools

Data were gathered using a "Demographic Information Form," "Pittsburgh Sleep Quality Index (PSQI)," and "Cornell Musculoskeletal Discomfort Questionnaire."

**Demographic Information Form:** A demographic information form consisting of a total of 6 questions was used to collect data on participants' age, gender, occupational group, height, weight, and congenital musculoskeletal system problems. This form was developed by the researchers in line with the study's objectives and scope, following a review of similar studies in the literature. The questions were meticulously designed to determine the participants' basic demographic and health characteristics, create subgroups for data analysis, and relate the results to relevant variables.

**Pittsburgh Sleep Quality Index (PSQI):** The Pittsburgh Sleep Quality Index (PSQI) was used to evaluate participants' sleep quality. PSQI is a self-report tool that measures various dimensions such as sleep duration, sleep quality, sleep latency, and sleep disturbances. The Pittsburgh Sleep Quality Index was developed by Buysse et al. in 1989 to assess the sleep quality of patients over a one-month period in clinical studies. The validity and reliability studies of the scale in our country were conducted by Ağargün et al. in 1996 (14).

PSQI consists of 24 questions in total. Of these, 19 are self-assessment questions, while the remaining 5 are to be answered by the participant's roommate or spouse, if applicable. The 19th question in the scale inquires whether the participant has a roommate or spouse, and the response to this question is not included in the scoring. For calculating the total PSQI score and component scores, only the first 18 questions answered by the participant are included.

In this study, the Cronbach's alpha value for the scale was calculated as 0.79. This value indicates a high level of internal consistency and confirms that the scale is a reliable measurement tool.

**Cornell Musculoskeletal Discomfort Questionnaire:** This questionnaire was used to evaluate the frequency and severity of musculoskeletal disorders in areas such as the lower back, upper back, and neck, as well as the impact of these disorders on daily life. The Turkish validity and reliability study of the scale was conducted by Erdinç et al. in 2011 (15). In this study, the Cronbach's alpha value for the scale was calculated as 0.56, indicating a moderate level of internal consistency.

The questionnaire assesses the frequency, severity, and work-impairing effects of musculoskeletal disorders in various body regions. Participants are asked to indicate how often they have experienced pain in the specified regions over the past week.

- Pain frequency is rated on a 5-point Likert scale (1: Never felt it, 5: Felt it many times every day).
- Pain severity is measured on a 3-point Likert scale (1: Mild pain, 3: Severe pain).
- Work impairment is scored on a 3-point Likert scale (1: Not at all limiting, 3: Very limiting).

For each region, a total score ranging from 0 to 90 is calculated. An increase in the score indicates that the pain is more frequent and severe, resulting in greater restrictions on the individual's work performance and daily functionality. Conversely, a decrease in the score suggests that the pain is less frequent and mild, improving the individual's functionality and reducing the impact on their work.

This scale serves as an effective tool for understanding the effects of musculoskeletal disorders on individuals and identifying intervention needs.

**Physical ergonomics training:** The training began with an introduction to the fundamental anatomy and mechanics of the spine, emphasizing the definition and importance of proper posture. The causes of lower back, upper back, and neck pain were explained in detail, and correct posture techniques were demonstrated to all participants individually. Within the scope of posture applications, participants were taught how to maintain proper posture during daily activities such as desk work, bending down, lifting objects from the ground, and reaching for high shelves.

Additionally, ergonomic recommendations were provided to support lower back and neck health, and a home exercise program was developed. This program included strengthening and stretching exercises designed to enhance the flexibility and strength of the neck and back muscles. It aimed to support participants' musculoskeletal health and help them maintain postural balance in their daily activities. The exercises were structured to be easily integrated into participants' daily lives, with goals of improving muscle endurance, reducing muscle tension, and preventing posture-related disorders.

Participants were instructed to perform the home program regularly three days a week for four weeks. During this period, participants were contacted by phone every Monday to remind them of the program and check whether they had completed the exercises from the previous week. This follow-up method was intended to improve participants' adherence to the program and maintain their motivation.

The training and home program aimed to support participants' postural health in daily life by combining theoretical knowledge with practical applications. Feedback collected throughout the process indicated that such individual follow-up and support methods played a significant role in enhancing the program's effectiveness.

### 2.4. Statistical analysis

Continuous data were analyzed using SPSS 29.0. The Kruskal-Wallis and Shapiro-Wilk tests evaluated normal distribution, and significant differences in non-normally distributed variables between initial and final measurements were assessed using the Wilcoxon method.

## 3. Results

The demographic information of the participants is presented in Table 1.

**Table 1.** Demographic Data of the Participants

| | Subcategory | Percentage (%) |
|---|---|---|
| **Gender** | Male | 84% |
| | Female | 16% |
| **Occupational Group** | Blue-Collar Worker | 72% |
| | White-Collar Worker | 28% |
| **Height** | Shorter than 167 cm | 12% |
| | 167 - 172 cm | 36% |
| | 177 - 182 cm | 16% |
| | 182 – 187 cm | 24% |
| **Weight** | Less than 65 kg | 16% |
| | 65 - 71 kg | 32% |
| | 71-77 kg | 8% |
| | 77-83 | 24% |
| | 83-90 kg | 12% |
| **Age** | Younger than 35 years | 16% |
| | 35 - 38 years | 20% |
| | 38-41 years | 8% |
| | 41-44 years | 28% |
| | Older than 44 years | 28% |

Table 2 shows the comparison between the average scores of the initial and final measurements on the Pittsburgh Sleep Quality Index. Accordingly, the average score of the initial measurement was found to be 10.398, while the final measurement average was 8.080. The score obtained in the final measurement showed a statistically significant difference compared to the initial measurement score (Z=3.061; p=0.002).

**Table 2.** Pittsburgh Sleep Quality Index Data

| | N | Average | SS | Minimum | Maksimum | Z | p |
|---|---|---|---|---|---|---|---|
| **Pittsburgh.first** | 25 | 10,398 | 2,7786 | 5,0 | 15,0 | 3,061[b] | ,002 |
| **Pittsburgh.final** | 25 | 8,0800 | 2,72596 | 5,00 | 15,50 | | |

Table 3 presents the findings evaluating the impact of ergonomics training on upper extremity musculoskeletal problems. The data compare the levels of pain or discomfort in various body regions before and after the training based on average scores. A statistically significant reduction in neck pain was observed post-training compared to pre-training (Z = -2.941, p = 0.003), indicating a positive effect of the training on neck pain. While reductions in pain levels were also noted in the right and left shoulders and back regions, these changes were not statistically significant (p > 0.05). A decrease in pain levels in the lower back was observed as well, but this change was also not statistically significant (p = 0.291). No significant changes were recorded in other body regions (upper arm, forearm, wrist). These findings demonstrate that ergonomics training significantly improved neck pain but did not have a marked impact on other regions (Figure 1).

**Table 3.** Cornell Musculoskeletal Discomfort Questionnaire Upper Extremity Data

| | N | Average | SS | Z | p |
|---|---|---|---|---|---|
| **Neck first** | 25 | 7,140 | 14,8545 | -2,941 | ,003 |
| **Neck final** | 25 | 2,920 | 6,2026 | | |
| **Right Shoulder first** | 25 | 1,260 | 3,3946 | -1,761 | ,078 |
| **Right Shoulder final** | 25 | ,360 | 1,246 | | |
| **Left Shoulder first** | 25 | ,760 | 2,8582 | -1,342 | ,180 |
| **Left Shoulder final** | 25 | ,300 | 1,224 | | |
| **Back first** | 25 | 8,600 | 24,8105 | -1,262 | ,207 |
| **Back final** | 25 | 5,740 | 14,2610 | | |
| **RightUpperArmfirst** | 25 | ,060 | ,3000 | ,000 | ,317 |
| **RightUpperArmfinal** | 25 | ,12 | ,4153 | | |
| **LeftUpperArmfirst** | 25 | ,36 | 1,8 | 2,0 | ,592 |
| **LeftUpperArmfinal** | 25 | ,62 | 2,803 | | |
| **Lower Back first** | 25 | 7,580 | 19,3373 | 1,055 | ,291 |
| **Lower Back final** | 25 | 3,420 | 8,5619 | | |
| **Right Forearm first** | 25 | ,000 | ,0000 | ,0000 | ,0000 |
| **Right Forearm final** | 25 | ,000 | ,0000 | | |
| **Left Forearm first** | 25 | ,375 | 1,8371 | ,000 | ,317 |
| **Left Forearm final** | 25 | ,000 | ,000 | | |
| **Right Wrist first** | 25 | ,360 | 1,2460 | 2,0 | ,256 |
| **Right Wrist final** | 25 | ,06 | ,3000 | | |
| **Left Wrist first** | 25 | ,24 | 1,2000 | ,000 | ,317 |
| **Left Wrist final** | 25 | ,0000 | ,0000 | | |

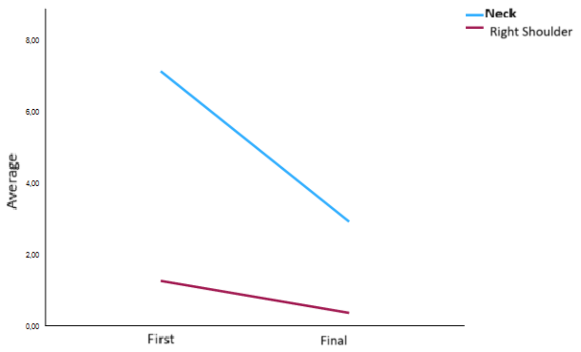


**Figure 1.** Initial and Final Measurements with Significant Differences

Table 4 presents the findings evaluating the impact of ergonomics training on lower extremity musculoskeletal problems. The data compare the levels of pain or discomfort in the hip, upper leg, knee, lower leg, and foot regions before and after the training based on average scores. A reduction in pain levels was observed in the hip region after the training compared to before, but this change was not statistically significant ($Z = -1.192$, $p = 0.233$). Changes in average scores were also recorded for the right and left upper legs, knees, lower legs, and feet, but none of these changes were statistically significant ($p > 0.05$). These findings indicate that ergonomics training did not have a significant effect on lower extremity musculoskeletal problems.

**Tablo 4.** Cornell Musculoskeletal Discomfort Questionnaire Lower Extremity Data

| | N | Average | SS | Z | p |
|---|---|---|---|---|---|
| **Hip first** | 25 | ,880 | 1,9164 | -1,192 | ,233 |
| **Hip final** | 25 | ,320 | ,9341 | | |
| **RightUpper Legfirst** | 25 | ,120 | ,6000 | -,447 | ,655 |
| **RightUpper Legfinal** | 25 | 1,320 | 6,2946 | | |
| **Left Upper Leg first** | 25 | ,180 | ,6595 | -,447 | ,654 |
| **Left Upper Leg final** | 25 | 1,380 | 6,2887 | | |
| **Right Knee first** | 25 | 1,080 | 4,1825 | -,211 | ,833 |
| **Right Knee final** | 25 | 1,100 | 2,8137 | | |
| **Left Knee first** | 25 | 1,080 | 4,1825 | ,948 | ,343 |
| **Left Knee final** | 25 | 1,500 | 4,3970 | | |
| **RightLower Legfirst** | 25 | ,260 | ,9028 | ,542 | ,588 |
| **RightLowerLegfinal** | 25 | 1,500 | 6,2899 | | |
| **LeftLowerLegfirst** | 25 | ,180 | ,6595 | -1,289 | ,197 |
| **LeftLowerLegfinal** | 25 | 1,560 | 6,2821 | | |
| **Right Foot first** | 25 | 1,020 | 3,0669 | -,431 | ,667 |
| **Right Foot final** | 25 | ,360 | ,8958 | | |
| **Left Foot first** | 25 | 1,020 | 3,0669 | -,689 | ,491 |
| **Left Foot final** | 25 | ,300 | ,7500 | | |

## 4. Discussion

The study evaluating the effects of physical ergonomics training on sleep quality and musculoskeletal system disorders among factory workers found that such training improved sleep quality and reduced musculoskeletal issues, particularly in the neck region.

Physical ergonomics awareness training is applied to reduce the risk of workplace injuries and enhance productivity. However, a previous study emphasized that working in an ergonomically appropriate environment alone is insufficient to reduce health problems. Awareness training plays a critical role in improving work performance and preventing musculoskeletal disorders. Such training enhances ergonomic awareness, reducing work-related health issues and associated productivity losses (16).

Ramos et al. (2018) evaluated the effects of Transcutaneous Electrical Nerve Stimulation (TENS) and posture exercises on musculoskeletal discomfort, fatigue, transverse abdominis activation, and functionality in patients with lumbar disc herniation. Positive results were observed across all parameters, including sleep quality (17). Consistent with the literature, our study found that the home exercise program, provided alongside ergonomics training, significantly reduced musculoskeletal issues among participants. These findings highlight the importance of physical ergonomics training and exercises in reducing musculoskeletal problems among factory workers.

Numerous studies in the literature have examined the impact of exercise and ergonomics training on musculoskeletal disorders in individuals from different sectors. Many studies have highlighted the effectiveness of exercise programs in reducing pain levels associated with musculoskeletal disorders, such as chronic lower back, neck, and upper back pain, among workers in various professions (18, 19, 20, 21). In our study, a significant reduction in neck pain was observed after the training, while reductions in pain levels in the right and left shoulders, back, and lower back were not statistically significant. No significant changes were recorded for other body regions (upper arm, forearm, wrist). Tanır et al. (2013) conducted a study involving 680 workers in an automotive factory who had taken medical leave due to musculoskeletal disorders in the past year. Ergonomics and posture correction training resulted in significant pain reductions in lower back, neck, and upper extremity regions (22). Similarly, another study focusing on ergonomics training for operating room nurses showed significant reductions in discomfort and risks, particularly in regions like ankles, wrists, back, neck, hips, and shoulders, after a three-month program (23).

Regarding lower extremity musculoskeletal problems, reductions in pain levels were observed in the hip region post-training. Changes in pain levels in the upper and lower legs, knees, and feet were also recorded but were not statistically significant. These findings indicate that ergonomics training did not significantly affect lower extremity musculoskeletal problems.

The study confirmed that physical ergonomics training improved participants' sleep quality. Pehlevan et al. conducted a randomized controlled trial among factory workers with back pain. Workers were divided into two groups, both receiving physical ergonomics training, with one group also undergoing stretching and posture exercises. Significant improvements in sleep quality, alongside reductions in pain and fatigue, were observed in the exercise group (24). Studies suggest that a combination of exercise programs and ergonomics training is more effective in managing functionality and pain intensity. Based on these findings and the current study, a workplace-specific ergonomics and physical exercise program can effectively reduce pain and improve functionality in workers with chronic pain.

Another study investigating the relationship between musculoskeletal disorders and sleep quality among office workers found that 83.3% had musculoskeletal problems and 74.7% reported poor sleep quality. Workers with musculoskeletal issues showed significantly worse sleep quality compared to those without (25). Consistent with our findings, musculoskeletal disorders appear inversely related to sleep quality.

Thus, the importance of ergonomics training in improving sleep quality and indirectly enhancing life quality among factory workers cannot be underestimated.

## 5. Conclusion and Recommendations

The study found that physical ergonomics training improved sleep quality and reduced musculoskeletal disorders in the neck region among factory workers. Further research involving larger participant groups is needed to explore the effects of physical ergonomics training on factory employees more comprehensively. It is recommended that physical ergonomics training be provided to factory workers to enhance their well-being, maximize workplace productivity, and reduce workforce losses due to health problems.

**Limitations**

The study's limitations include its implementation at a single center, the relatively small sample size, and the absence of long-term follow-up.

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