RESEARCH ARTICLE

# Effects of ergonomic training and equipment on musculoskeletal system disorders and quality of life in healthcare professionals

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## Abstract

**Objective:** To determine the association of musculoskeletal disorders with ergonomic training and equipment with respect to the quality of life of nurses working in the intensive care unit.

**Method:** The experimental study was conducted at Eskisehir Osmangazi University Health, Practice and Research Eskisehir, Turkiye from November 2018 to December 2019, and comprised adult intensive care unit nurses. The nurses were provided with ergonomic equipment (rollboards) to facilitate the transfer patients from bed to stretcher and from stretcher to bed. The nurses were trained on the use of rollboards for a month. Data was collected at baseline and after the training using a personal data collection form, Cornell Musculoskeletal Discomfort Questionnaire, Rapid Entire Body Assessment, and Short Form-36. Data was analysed using SPSS 21.

**Results:** Of the 103 nurses, 71(58.9%) were females and 32(31.1%) were males. There were 30(29.1%) subjects aged 25-29 years, and body mass index was <25kg/$m_2$ in 62(60.2%). Median risk score for lower back was 3.50 (interquartile range: 1.50-14.00; Z=-2.58, p=0.01) and for risky working posture it was 5.00 (interquartile range: 5.00-7.00; Z=-8.39, p<0.001) of nurses which decreased after training and the use of equipment. The sub-dimension scores of the quality of life for the physical function, mental health, social function, general health perception and pain decreased post-intervention, but the difference was not significant (p>0.05).

**Conclusion:** Nurses' musculoskeletal symptoms decreased as a result of ergonomic training and equipment use. Although ergonomic training and equipment use did not affect nurses' quality of life, the ergonomic workplace increased their awareness of ergonomic risk assessment.

**Key Words:** Education, Ergonomics, Musculoskeletal system, Nurses, Quality of life.

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## Introduction

Musculoskeletal disorders (MSDs) are defined as mild pain and dysfunctions affecting various parts of the body, such as the elbow, shoulder, neck, low back, feet and legs. If the MSDs are left untreated, they may cause lifelong physical dysfunction.[1] In various occupational groups, especially healthcare professionals, MSDs are a common cause of occupational morbidity which affects life negatively.[2]

In 2018, nurses were in the second place with respect to MSDs reported worldwide, with 17,240 cases.[3] The occurrence of MSDs may be influenced by multiple factors, like physical factors, environmental factors, organisational factors, and pre-existing MSD symptoms.[4] For nurses, the nature of their work entails standing for long hours, heavy lifting/transferring, pushing/pulling, and awkward postures that are common risk factors for MSDs.[4,5] It has been emphasised that the occurrence of MSDs is generally higher among nurses working in intensive care units (ICUs).[6] Çelik et al. reported that critical care nurses mostly experience lower back pain (LBP) (88.3%), and changing bed linens while the patient remained in bed, lifting, pulling, or pushing heavy materials caused such a pain.[5]

MSD symptoms, like pain or limitation of movement, affect practice of the profession and negatively affect the quality of life (QOL) of the nurses.[7] Therefore in the nursing profession, using ergonomic equipment and giving ergonomic training may reduce the risks that an employee encounters, and increase labour productivity and QOL.[8]

In this context, the Centres for Disease Control and Prevention (CDC) emphasises the importance of using ergonomic equipment to improve the health and safety of employees and patients.[9] In addition, studies have shown that the use of ergonomic equipment prevents absenteeism, and reduces MSDs, harmful body postures, personnel requirements and costs, thus increasing the quality of patient care.[10,11] Given that the nurses need to

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be healthy to be able to provide healthcare services of good quality, the importance of suitable ergonomic facilitation in working environments is clear. The Occupational Safety and Health Administration of the United States Department of Labour proposes plans that define ergonomic risk factors and the measures to be taken against them in the health and safety plans for work environments. These plans include workplace analysis, accident/record analysis, as well as collecting data on MSD on a regular basis, increasing the number of trained personnel, and providing continuous training.[12] In literature reviews conducted on the subject, it has been reported that the training using a multidisciplinary approach for ergonomic risks and appropriate posture may reduce the frequency of pain, and that ergonomic equipment may increase awareness of MSDs.[13,14]

In Turkey, the participation of healthcare workers in ergonomic training programmes and the ergonomic organisation of the work environments has only recently begun to be analysed. Nurses experience at least one kind of musculoskeletal pain or discomfort, and the incidence of up to 96% in the health sector emphasises the importance of conducting more studies on the prevention of MSDs.[15]

The current study was planned to determine the association of MSDs with ergonomic training and equipment with respect to the QOL of ICU nurses.

## Subjects and Methods

The experimental study was conducted at Eskisehir Osmangazi University Health, Practice and Research Hospital from November 2018 to December 2019, and comprised adult ICU nurses who did not have any known MSDs and who volunteered to participate. Those who were pregnant, working in paediatric ICUs, had any MSD, and those who did not agree to participate were excluded. The sample was raised using total sampling method.[16] Approval was obtained from the Non-Interventional Clinical Research Ethics Committee of Eskisehir Osmangazi University, and informed consent was taken from all the participants. At the baseline, data collection forms were filled, which took about 10 minutes, and photographs of the nurses were taken while they were moving a patient from the bed to a stretcher. The posture risk to the whole body was calculated.

Six pieces of ergonomic equipment (rollboards) were delivered to the ICUs in which ergonomics training had been given on how to transfer a patient from bed to stretcher and from stretcher to bed. Each ICU was given a pictorial manual explaining how to use the rollboard, and the use of rollboard was explained and demonstrated, after which each nurse was allowed to use it individually. All queries of the nurses were answered. One month after the training and the provision of the rollboard, data was collected again, and photographs were taken while the patient was being moved from the bed to the stretcher with the help of the rollboard. The posture risk to the whole body was calculated for each nurse.

Data was collected using a personal data collection form, Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), Short Form-36 (SF-36) and Rapid Entire Body Assessment (REBA) form. The personal data form consisted of 30 questions generated in the light of literature.[17,18] The CMDQ is a data collection tool developed at the Human Factors and Ergonomics Laboratory at Cornell University for the assessment of musculoskeletal symptoms. It assesses the frequency and severity of pain and its interference with work over the preceding week. The total discomfort score for each body part ranges 0-90.[19] The SF-36 is one of the many measurement tools that evaluate QOL. The scale consists of 36 questions covering 8 health dimensions. The scale produces total score as well as subscale scores. Subscale scores range 0-100, with 0 = poor health and 100 = good health.[20] The REBA evaluates the postural risk of the whole body in dynamic and static posture, and also assesses whether the discomfort decreases post-intervention. In the REBA method, the body is divided into two groups, and scored according to the posture and position of the body parts in each group. In the REBA scores, 1 point indicates a negligible risk, 2-3 points indicate low risk and that changes may be necessary, 4-5 points indicate medium risk and that changes are necessary, 8-10 points indicate high risk needing investigation, and a score of 11 and above indicates very high risk and the need to implement the change.[21]

Data was analysed using SPSS 21. Data was expressed as mean ± standard deviation, median with interquartile range (IQR), or as frequencies and percentages, as appropriate. Data normality was checked using Shapiro-Wilk test. For normal, continuous data comparison, paired t-test was used. For intergroup comparison for non-normally distributed data Wilcoxon signed ranks test was used. $P<0.05$ was considered significant.

## Results

Of the 125 nurses relevant to the study, 103(82.4%) met the inclusion criterion and were included. There were 71(58.9%) females and 32(31.1%) males. There were 30(29.1%) subjects aged 25-29 years, and body mass index (BMI) was $<25 kg/m_2$ in 62(60.2%) (Table 1).

At baseline, QOL sub-dimension median score for vitality

**Table-1:** Socio-demographic characteristics.

| Sociodemographic Characteristics | n | (%) |
|---|---|---|
| **Age (years)** | <25 | 28 |
| 27.2 | | |
| 25-29 | 30 | 29.1 |
| 30-34 | 25 | 24.3 |
| ≥35 | 20 | 19.4 |
| **Gender** | | |
| Female | 71 | 68.9 |
| Male | 32 | 31.1 |
| **BMI(kg/m$^2$)** | | |
| <25(kg/m2) | 62 | 60.2 |
| 25 and above(kg/m$^2$) | 41 | 39.8 |
| **Educational Level** | | |
| High School | 43 | 41.7 |
| University | 60 | 58.3 |
| **Marital Status** | | |
| Married | 52 | 50.5 |
| Single | 51 | 49.5 |
| **Department** | | |
| Internal Diseases ICU | 51 | 49.5 |
| Surgical ICU | 52 | 50.5 |
| **Years of Experience in Current Workplace** | | |
| 0-1 year | 28 | 27.2 |
| 2-5 years | 45 | 43.7 |
| ≥ 6 years | 30 | 29.1 |
| Total | 103 | 100 |

BMI: Body mass index, ICU: Intensive care unit.

50.00 (IQR: 35.00-65.00) and role limitation due to physical problems 50.00 (IQR: 25.00-100.00) were the lowest. The physical functioning, mental health, social functioning, general health perception and pain sub-dimension scores decreased post-intervention (Figure 1). Before and after the training and the use of ergonomic equipment, there was no significant change between the nurses' sub-dimension scores for QOL (p>0.05) (Table 2).

Nurses' most complained MSD was LBP (Figure 2). Post-intervention MSD risk scores decreased 3.50 (IQR: 1.50-14.00). MSD risk scores showed a significant change with respect to neck, left shoulder, back, lower back, left thigh and left foot after the intervention (p<0.05) (Table 3).

Total REBA scores of the nurses decreased with respect to working posture 5.00 (IQR: 5.00-7.00)] (Figure 2). The difference was significant (p<0.001) compared to the baseline (Table 3).

**Table-2:** Comparison of sub-dimension scores of quality of life (QOL).

| Subdimensions of QoL Scale | Before Median ($Q_1$–$Q_3$) | After Median ($Q_1$–$Q_3$) | Comparison of QoL SubDimension Scores Z | p |
|---|---|---|---|---|
| Physical Functioning | 85.00(60.00-95.00) | 80.00(65.00-90.00) | -0.96a | 0.36 |
| Role limitation due to Physical problems | 50.00(25.00-100.00) | 50.00(0.00-100.00) | -0.33a | 0.18 |
| Role limitation due to Emotional problems | 66.67(33.33-100.00) | 66.67(33.33-100.00) | 1.13a | 0.25 |
| Energy/Vitality | 50.00(35.00-65.00) | 50.00(35.00-60.00) | 0.25a | 0.80 |
| Mental Health | 64.00(48.00-76.00) | 60.00(48.00-68.00) | 0.96a | 0.33 |
| Social Functioning | 62.50(37.50-87.50) | 50.00(37.50-75.00) | 1.29a | 0.19 |
| General Health Perception | 55.00(40.00-70.00) | 50.00(40.00-65.00) | 0.40a | 0.68 |
| Pain (mean±SD) | 55.99±26.86 | 54.73±23.21 | 0.52b | 0.60 |

Q1: 25%, Q3: 75%, SD: Standard deviation, [a] Analysed with Wilcoxon signed ranks test. [b] Analysed with paired sample t test.

**Table-3:** Comparison of Cornell MSD risk scores by body part, and REBA score.

| Body Part | | Before Median ($Q_1$–$Q_3$) | After Median ($Q_1$–$Q_3$) | Comparison of Cornell MSD Risk Scores and Total REBA Scores Z | p |
|---|---|---|---|---|---|
| **Neck** | | 3.00(0.00-10.00) | 3.00(1.50-7.00) | -2.05[a] | 0.04 |
| **Shoulder** | Right | 1.50(0.00-7.00) | 1.50(0.00-6.00) | -1.73[a] | 0.08 |
| | Left | 1.50(0.00-7.00) | 1.50(0.00-4.50) | -2.14[a] | 0.03 |
| **Back** | | 6.00(0.00-20.00) | 1.50(0.00-8.50) | -3.64[a] | <0.001 |
| **Upper Arm** | Right | 0.00(0.00-1.50) | 0.00(0.00-1.50) | -1.28[a] | 0.20 |
| | Left | 0.00(0.00-1.50) | 0.00(0.00-1.50) | -0.79a | 0.42 |
| **Lower Back** | | 7.00(1.50-20.00) | 3.50(1.50-14.00) | -2.58a | 0.01 |
| **Lower Arm** | Right | 0.00(0.00-1.50) | 0.00(0.00-1.50) | -0.74a | 0.45 |
| | Left | 0.00(0.00-1.50) | 0.00(0.00-0.00) | -0.69a | 0.48 |
| **Wrist** | Right | 0.00(0.00-1.50) | 0.00(0.00-1.50) | -1.58a | 0.11 |
| | Left | 0.00(0.00-1.50) | 0.00(0.00-1.50) | -0.51a | 0.60 |
| **Hip** | | 0.00(0.00-1.50) | 0.00(0.00-1.50) | -1.00a | 0.31 |
| **Thigh** | Right | 0.00(0.00-3.12) | 0.00(0.00-1.50) | -1.80a | 0.07 |
| | Left | 0.00(0.00-3.00) | 0.00(0.00-1.50) | -1.96a | 0.04 |
| **Knee** | Right | 0.00(0.00-6.00) | 0.00(0.00-3.50) | -0.84a | 0.39 |
| | Left | 0.00(0.00-6.00) | 0.00(0.00-3.00) | -1.46a | 0.14 |
| **Lower Leg** | Right | 0.00(0.00-6.00) | 0.00(0.00-5.00) | -0.37a | 0.71 |
| | Left | 0.00(0.00-6.00) | 0.00(0.00-3.12) | -1.01a | 0.30 |
| **Foot** | Right | 1.50(0.00-8.50) | 1.50(0.00-6.00) | -1.79a | 0.07 |
| | Left | 1.50(0.00-7.00) | 0.00(0.00-6.00) | -2.24a | 0.02 |
| **Total REBA Score** | | 8.00(7.00-10.00) | 5.00(5.00- 7.00) | -8.39a | <0.001 |

Q1: 25%, Q3: 75%, MSD: musculoskeletal disorders, REBA: Rapid entire body assessment.
[a] Analysed with Wilcoxon signed ranks test,

## Discussion

The most important risk factor associated with the increased incidence of MSDs in the nursing profession is work activities. In particular, the greater physical effort exerted by ICU nurses also increases their susceptibility to MSDs.[6] Ergonomics, which discusses how a job can be tailored to the physical and psychological characteristics of the employee, may not prevent the onset and progression of MSDs. In this

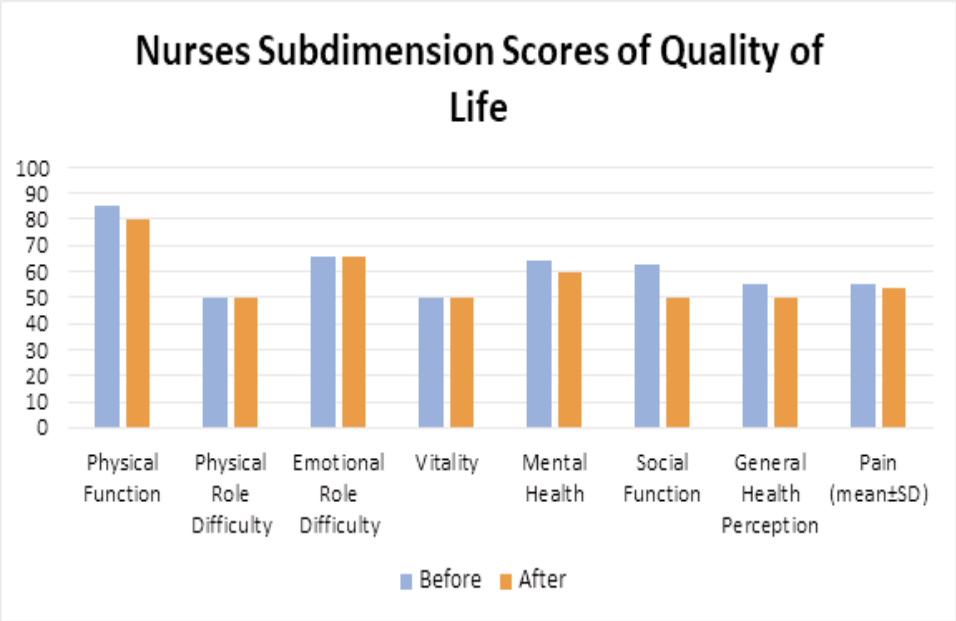


**Figure-1:** Sub-dimension scores of quality of life before and after training and the use of ergonomic equipment.

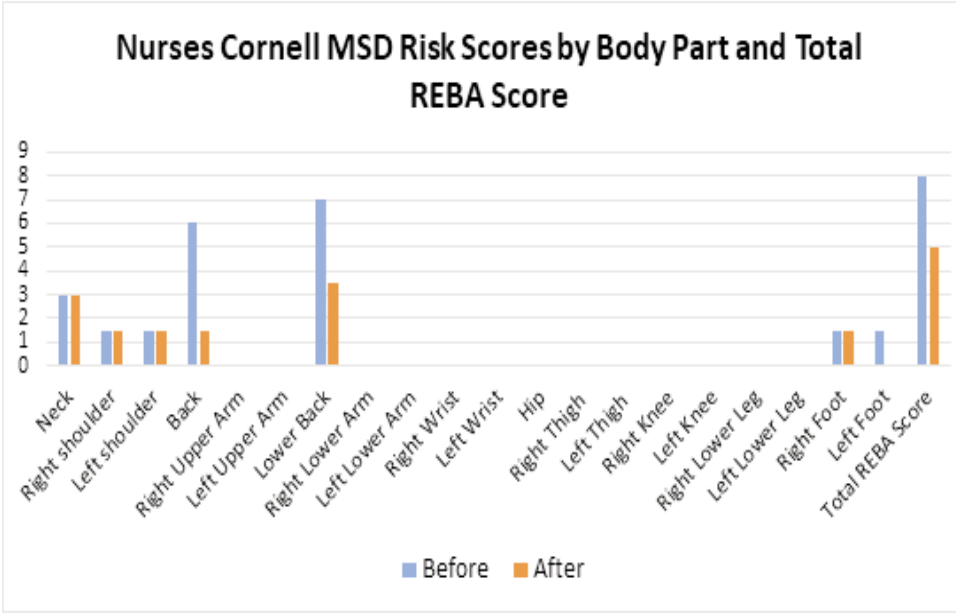


**Figure-2:** Cornell musculoskeletal disorder (MSD) risk scores by body part and rapid entire body assessment (REBA) score before and after training and the use of ergonomic equipment.

context, it is envisaged that nurses' motivation, job satisfaction, job stress as well as the incidence of MSDs will decrease with ergonomic conditions, ergonomic equipment and training to create ergonomic awareness.[1,8,11]

The current study observed that the sub-dimension scores for QOL decreased or did not change after the training and the use of ergonomic equipment. In contrast, a study reported that ergonomic training had a positive impact on nurses' QOL.[22] Another study reported that a 12-week training programme for correct body posture together with ergonomic environmental planning decreased pain and increased QOL.[23] QOL is a concept affected by environmental and psychosocial factors that include an individual's perceptions about life, individual values, goals and concerns. Due to the nature of the job, nurses encounter these factors that affect QOL more frequently. However, QOL is affected by more several factors, and it may be difficult to create working conditions that will increase the QOL of nurses compared to other lines of business.[24,25] The difference between current results and the literature may also be due to QOL getting affected by multiple factors, nature of the nursing profession and because ICU nurses do not have time to use ergonomic equipment in critical and emergency situations.

Another result in current study was that the nurses most complained about LBP and that the nurses' back, lower back and left foot MSD risk scores decreased after training and use of ergonomic equipment. A statistically significant change was observed ($p<0.05$) between the nurses' MSD risk scores for left shoulder, back, lower back, left upper leg and left foot between baseline and post-intervention scores. A 2021 study reported that LBP was found to occur significantly less among nurses who used lifting equipment.[26] A 2020 study reported that the nurses' risk of MSDs decreased in the intervention group after an educational programme

(p=0.03).1 In the literature, it is emphasised that practices for the prevention of MSDs should not be limited to the use of ergonomic equipment, but that this should be supported by regularly planned training programmes.[27] In addition, it is also reported that the reason for LBP being the most frequent MSD among ICU nurses is that these nurses often care for partially or completely bed-bound patients, and have only short breaks and limited staff strnegth.[28] In the current study, where similar results with the literature were obtained, the frequency of MSD symptoms or pain in some body parts of the nurses decreased after training and use of ergonomic equipment. This may have been because of better awareness post-intervention.

In the current study, total working posture scores decreased after the intervention to a moderate level, and a statistically significant change was observed between the working posture scores ($p<0.001$). A 2018 study reported that the use of patient-lifting equipment may reduce risky working posture scores during care-giving to a low level.[29] A 2017 study also reported that the mean risky working posture scores in manual patient transfer showed a very high risk, but, with the use of ergonomic equipment, these scores decreased to a medium level.[30] In the current study, similar results were obtained.

The current study has limitations as it excluded pregnant subjects and situations that prevent the continuous use of ergonomic equipment, such as emergency interventions and excessive workload of the nurses. To use ergonomic equipment in the study, the equipment must be placed under the patient. In cases requiring emergency intervention, such as cardiopulmonary arrest, the patient should be transferred from the stretcher to the bed without waiting for the ergonomic equipment to be placed under the patient, and airway patency should be maintained and massage should be started. Furthermore, nurses who did not want to waste time turning the patient and placing the ergonomic equipment underneath due to their workload may have transferred the patient without using the equipment. In addition, the burden on the body increases with pregnancy, and LBP and general back pain may be seen. It can be difficult to determine whether these pains are work-related, and any pregnant nurses in the institution where the study was carried out did not actively participate in patient transfer from bed to bed or to stretcher.

## Conclusion

Ergonomic training given to the nurses and their subsequent use of ergonomic equipment in nursing care practices had the potential to reduce MSDs. However, QOL is affected by many factors and is a multidimensional concept. It requires repeated evaluations in the long term in ergonomic training and equipment use. As such, the risk to ICU nurses needs to be evaluated at regular intervals and the QOL must be repeatedly assessed.

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**AUTHORS' CONTRIBUTIONS:**
**OK:** Concept, design, data collection, analysis, interpretation, drafting, final approval and agreed to be accountable for all aspects of the work.
**NK:** Concept, design, data interpretation, revision, final approval and agreed to be accountable for all aspects of the work.