RESEARCH

INVESTIGATION OF THE EFFECT OF FATIGUE LEVEL ON PLANTAR PRESSURE DISTRIBUTION IN HEAVY METALWORKERS

Abstract

This study aims to evaluate the relationship between static plantar pressure analysis and fatigue conditions in heavy metal factory workers routine working environments. 89 heavy metal factory workers with a mean age of 41.69 ± 9.82 were included in the study. The fatigue level of the participants was evaluated with the "Fatigue Severity Scale. Forefoot, hindfoot and total pressure distributions of right and left feet were analyzed with the static pedobarographic devices. The relationship between the variables was evaluated by Spearman correlation analysis. No significant correlation was found between fatigue level of workers and forefoot, hindfoot and total static plantar pressure distributions of right and left foot (p>0,05). There was no significant relationship between the fatigue level of heavy metalworkers and static plantar pressure distributions. In future studies, it is recommended that workers plantar pressure analyzes be evaluated dynamically during working hours.

Key words: Fatigue, plantar pressure distribution, worker

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ARAŞTIRMA

AĞIR METAL İŞÇİLERİNDE YORGUNLUK DÜZEYİNİN PLANTAR BASINÇ DAĞILIMINA ETKİSİNİN İNCELENMESİ

Öz

Bu çalışma, ağır metal fabrikası işçilerinin rutin çalışma ortamlarında statik plantar basınç analizi ile yorgunluk koşulları arasındaki ilişkiyi değerlendirmeyi amaçlamaktadır. Çalışmaya yaş ortalaması 41,69 ± 9,82 olan 89 ağır metal fabrikası işçisi dahil edildi. Katılımcıların yorgunluk düzeyleri "Yorgunluk Şiddeti Ölçeği" ile değerlendirildi. Sağ ve sol ayağın ön ayak, arka ayak ve toplam basınç dağılımları statik pedobarografik cihazla analiz edildi. Değişkenler arasındaki ilişki spearman korelasyon analizi ile değerlendirildi. Çalışanların yorgunluk düzeyleri ile sağ ve sol ayağın ön, arka ve toplam statik plantar basınç dağılımları arasında anlamlı bir ilişki bulunmadı (p> 0,05). Ağır metal işçilerinin yorgunluk seviyeleri ile statik plantar basınç dağılımları arasında anlamlı bir ilişki yoktu. İleride yapılacak çalışmalarda, çalışanların plantar basınç analizlerinin çalışma saatleri içerisinde dinamik olarak değerlendirilmesi önerilmektedir.

Anahtar kelimeler: Yorgunluk, plantar basınç dağılımı, işçi

1. Introduction

Heavy metalworkers who standing posture for a long time, especially posture muscles and leg muscles are constantly static contractions and cause muscle fatigue (1). It was stated that fatigue level did not affect ground reaction strength but short- or long-term exercises caused significant changes in muscle activation (2,3). In the gait analysis studies, it was found that exercise-related fatigue levels alleviated the shock waves in the heel stroke and the average power frequency of the electromyographic signals decreased after activities such as walking, running and cycling (4,5). Hennig et al. (6) stated that in the case of fatigue caused by exercise, the peak of plantar pressure in the middle foot decreases with fatigue and that these structures take place in balance and movement control.

In the literature, the relationship between fatigue and plantar pressure analysis, which is usually formed after walking or exercise, is examined. The study evaluating plantar pressure analyzes due to the fatigue level of heavy metalworkers in daily work environments could not be reached. In this context, this study aimed was to evaluate the relationship between heavy metalworkers' routine fatigue and static plantar pressure analysis.

2. Material and Methods

2.1. Study design

89 healthy male workers aged between 20-65 years, working in the heavy metalwork factory for at least 6 months were included in the study on a voluntary basis. Workers who underwent lower extremity surgery and who had foot deformity were excluded from the study. Our study was approved by the Istanbul Medipol University Institute of Health Sciences, Non-Interventional Clinical Studies Ethics Committee. Informed written consent by following the Declaration of Helsinki was obtained from all workers in the study.

2.2. Outcome measures

The demographic data of the participants were recorded. The Fatigue Severity Scale, which evaluates the level of fatigue in the last week, was completed. In this 9-point Likert-type scale, the questions were scored as disagree (0) and strongly agree (7) and the total score obtained was divided by the number of items (7). The static pedobarographic device was used to evaluate the plantar pressure analysis of the workers. During the measurement, the workers were asked to look at the opposite wall in an upright position and stand on the pedobarographic device with a step width of 8 cm. As a result of the analysis, the total pressure of right and left foot, and forefoot and hindfoot pressures were determined as percentages (8).

2.3. Statistical analysis

The SPSS 18.0 statistical package program was used for statistical analyses. Data were expressed as mean, standard deviation, and percentages. The One-Sample Kolmogorov Smirnov test did not show the normal distribution for all variables. The relationship between variables was tested by the Spearman correlation test. The p-value of less than 0.05 was considered significant.

3. Results

A total of 89 male workers were included in the study (mean age 41.69 ± 9.82, weight average 73.33 ± 18.15). Demographic characteristics, fatigue levels and percentages of forefoot, hindfoot and total pressure of both feet were shown in Table 1. The correlation analysis between the variables is shown in Table 2. There was no significant relationship between fatigue severity and forefoot, hindfoot and total plantar pressure analyzes of the right and left foot. ($p>0.05$) (Table 2).

Table 1. Demographic characteristics

	Min-Max	Mean±SD
Age	21.00-74.00	41.69±9.82
Height (m)	1.63-64.00	17.42±24.62
Weight (kg)	31.00-110.00	73.33±18.15
Left forefoot	1.70-71.00	47.81±12.56
Left hindfoot	29.00-83.00	49.21±9.61
Left total pressure	0.00-65.00	39.93±24.51
Right forefoot	29.00-83.00	48,23±11,85
Right hindfoot	1.64-71.00	33.87±23.31
Right total pressure	32.00-110.00	56.23±19.05
Fatigue severity scale	0.00-7.00	2.41±1.36

Min-Max:Minumum-Maximum, SD:Standart Deviation, m:meter, kg:kilogram

Table 2. Relationship analysis between variables

Plantar pressure distribution		Fatigue severity scale
Left forefoot pressure	r	0.05
	p	0.61
Left hindfoot pressure	r	0.08
	p	0.43
Left total pressure	r	0.18
	p	0.09
Right forefoot pressure	r	0.06
	p	0.57
Right hindfoot pressure	r	0.18
	p	0.07
Right total pressure	r	-0.16
	p	0.13

$p<0.05$, Spearman correlation test

4. Discussion

This study aimed to determine whether there is a relationship between fatigue levels in the last week and plantar pressure analysis of male workers working in heavy metalwork factory. Studies in the literature generally have examined the relationship between exercise-induced fatigue and plantar pressure analysis (9,10). Wilson et al. (2) reported that participants who had fatigue with treadmill exercise changed their plantar surface loading properties to increase tolerance to fatigue. In this sense, it showed that participants reduced heel loading and increased medial forefoot loading. Hennig et al. (6) stated that the plantar pressure peak in the middle foot decreased with fatigue.

No significant relationship was found between the fatigue level of the workers included in our study and the forefoot, hindfoot and total plantar pressure analyzes of right and left foot. Bisiaux et al. (11), immediately after exercise and after 30 minutes of rest, the analysis found that the forefoot and hindfoot plantar pressures were significantly affected. In our study, the mean fatigue level of the participants was determined as 2.41 ± 1.36. Despite the heavy working conditions and the tests conducted during the last hour of daily work, the fatigue level of the workers is not high according to the scale calculations. This may be the reason why our study results do not show parallelism with the literature.

In a study examining the effects of plantar flexor muscle fatigue on postural control during fixed posture and perturbation in healthy individuals; found that plantar muscle fatigue during standing still has no significant effect on postural control parameters. In the same study, after perturbation, it was observed that the average displacement of the center of pressure in the anteroposterior direction, speed and path length increased after fatigue. These results indicated that the effects of muscle fatigue on postural control depend on the difficulty of the task and the relevance of proprioceptive information (12). In our study, the postural control of the workers was not evaluated, their general fatigue levels were evaluated, and no relationship was established with the plantar pressure analysis.

Plantar pressure analysis; it was determined that the workers had more weight on the right foot (right total pressure %56,23±19,05, left total pressure %39,93±24,51) but had a more balanced distribution on the left foot. At the same time, it was found that the pressure on the right forefoot (%48.23 ± 11.85) was higher than the right hind foot (%33.87 ± 23.31). In the literature, different analysis of plantar pressure in the feet after fatigue have been shown in amateur runners with different medial arch heights (13). Medial arch heights were not evaluated in our study. This result gives an idea about the working postures of the workers and suggests that it is appropriate to evaluate the working posture of the workers in future studies.

5. Conclusion

In our study, no significant relationship was found between fatigue levels of heavy metalworkers and static plantar pressure distributions. The limitations of the study include not evaluating the working posture and working year of the workers and the static analysis of plantar pressure. In future studies, it is recommended to evaluate the workers in more detail and to measure the plantar pressure analysis dynamically during working hours.

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