International Journal on Engineering Technologies and Informatics

Effect of Lifting Parameters on Perceived Exertion of Workers

Review Article

Volume 5 Issue 3- 2024

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Article History

Received: June 20, 2024 Accepted: June 24, 2024 Published: June 24, 2024

Abstract

Material Handling is one of the main causes of overexertion, leading to Musculoskeletal Disorders (MSDs). To prevent overexertion, the perceived exertion of workers during manual material handling tasks must be considered. This study aims to evaluate the effect of multiple lifting parameters on the perceived exertion level of workers. The lifting parameters considered are weight of lift, duration of lift, distance of lift, angle of lift, and frequency of lift. The effect of these lifting parameters was examined at two levels. Data was collected from 32 healthy participants, and they were assigned random lifting tasks. At the end of the experiment, each participant was asked to rate their perceived exertion level using Borg's scale C.R. 10. An ANOVA test was used to evaluate the lifting parameters that significantly impacted the perceived exertion level. The result indicates that the distance and frequency of lift significantly affected the perceived exertion level. In contrast, the lift duration had the least effect on the perceived exertion.

Keywords: Lifting Parameters; Manual Material Handling; Borg Perceived Exertion

Introduction

Musculoskeletal Disorders (MSDs) are disorders of the muscles, nerves, bones, joints, ligaments, cartilage, and tendons caused by long-term repetitive tasks, poor work practice, and forceful exertion. [1,2]. Shuai et al. [3] noted that countries such as Germany, Japan, Britain, and the United States have listed these disorders as occupational diseases. MSDs cause pain, disability, and suffering among workers. One of the leading causes of MSDs is overexertion. Liberty Mutual Insurance [4] reported that the cost of injuries due to overexertion accounted for about $13.98 billion in 2017. Manual material handling tasks are one of the leading causes of overexertion injuries because they usually require substantial effort [5,6]. Kamarudin [7] defines manual material handling as the moving or handling loads by lifting, lowering, bending, supporting, twisting, transporting, and other daily activities, whether once or regularly, using human energy and forces. The consequence of overexertion in most physical tasks is extreme fatigue. Workplace fatigue can affect workers' productivity and attentiveness, leading to increased workplace injuries and work errors [8].

The Rate of Perceived Exertion (RPE) scale is a valuable tool for expressing workers' feelings of intensity in any physical task. Borg [9] defines perceived exertion as the perception of the strenuousness of a physical activity. Elisabet and Gunnar [10] reported that perceived exertion has the advantage of measuring physiological variables that can function as validity criteria. Several studies have used the RPE scale to investigate the effect of various lifting parameters on perceived exertion during manual lifting tasks [11-15]. However, no study has examined the effect of five lifting parameters on perceived exertion level. This study aims to determine the impact of five lifting parameters on perceived exertion for a repetitive lifting task.

Methodology

The experiment includes five lifting parameters with two levels each. The lifting parameters are weight (8 and 12kg), duration (5 and 10 minutes), distance (35 and 70cm), angle of symmetry (0 and 90), and frequency (6 and 12 lifts per minute). Thirty-two treatments were used for this study, comprising a combination of these lifting parameters. Each participant was assigned to a single treatment combination, resulting in thirty-two participants. The mean age of the participants was 25 years. The participants rested for 15 minutes before lifting a box based on the assigned treatment combination from the knuckle height to the treatment distance. A helper lowered the box to its original position, so the participants were only involved in lifting it. The Gymboss interval timer application was used to control the lifting frequency. After the lifting task, the participants were asked to rate their perceived exertion level on the Borg CR10 Ratings of Perceived Exertion [Table 1]. Figure 1 shows a participant lifting from knuckle height to an assigned treatment height.

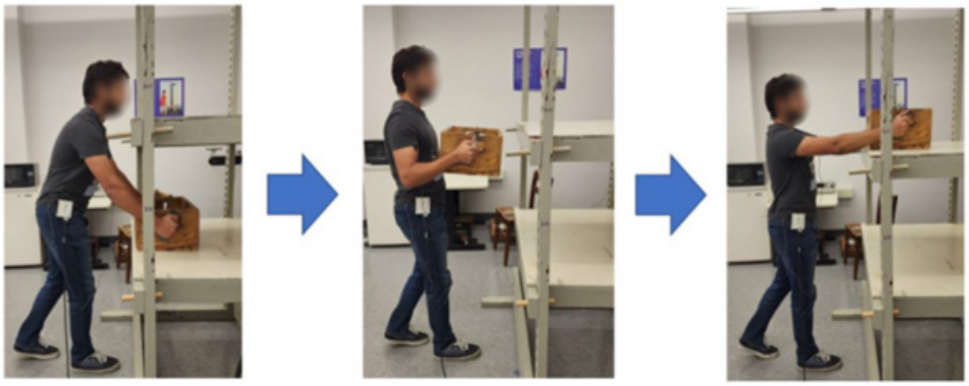

Figure 1: Participant Lifting Task.

Table 1: Borg Scale of Perceived Exertion.

Borg CR10 Ratings of Perceived Exertion	
10-Point Scale	
Rating	**Definition**
0	Nothing at all
0.5	Very, very easy
1	Very easy
2	Easy
3	Moderate
4	Somewhat hard
5	Hard
6	Very hard
7	
8	Very, very hard
9	
10	Impossible

Results

The mean and standard deviation of perceived exertion for the 8kg was 2.28 (1.13), while the mean and standard deviation for the 12kg was 2.66 (1.40). The mean value of the perceived exertion increased as the weight increased, having a percentage change of 16.67%. The mean and standard deviation of perceived exertion for the 6 lifts per minute was 1.88 (1.13). The mean and standard deviation of the perceived exertion for the 12 lifts per minute was higher than the 6 lifts per minute at 3.06 (1.12), with a percentage increase of 62.76%. The two levels of duration were 5 and 10 minutes. The mean and standard deviation of the perceived exertion for the 5 and 10 minutes were 2.41 (1.14) and 2.53 (1.41), respectively. The mean value of the perceived exertion is slightly higher with longer duration, having a percentage change of 4.97%.

The mean and standard deviation of the perceived exertion for the 35cm was 2.03 (1.16), while the mean and standard deviation for the 70cm was 2.91 (1.24). The mean value for the 70cm was higher than the 35cm, with a percentage increase of 43.35%. For the angle of symmetry, the mean and standard deviation of perceived exertion for the 0-degree and 90-degree were 2.69 (1.08) and 2.25 (1.42), respectively. The mean value for the 0-degree was higher than the 90-degree, with a percentage change of 16.35%. The changes in slopes of the different lifting parameters are shown in Figure 2. The frequency and distance had higher slopes than the other lifting parameters. The frequency distribution of the perceived exertion reading is shown in Figure 3.

An ANOVA test (p=0.05) was conducted to examine the effect of each lifting parameter on the perceived exertion level. The results of the ANOVA test are shown in Table 2. The frequency was found to have the most significant effect on the perceived exertion level. In addition, the lift distance also significantly affected the perceived exertion level. The duration of the lift had the least impact on the perceived exertion.

Discussion

The level of perceived exertion increased for all the lifting parameters except for the symmetry angle. The frequency had the highest increase in the perceived exertion level, followed by the distance of lift. The percentage increase for the frequency and distance of lift was 62.76% and 43.35%, respectively. The results of this study on the frequency of lift are consistent with the results of Wu [16], reporting that frequency significantly impacted perceived exertion. There was also an increase in the mean value of the perceived exertion from the lower end to the

higher end for weight (16.67%) and duration (4.97%). The mean value of the perceived exertion for the angle of symmetry decreased with a percentage decrease of 16.35%. The results of the ANOVA test show that the frequency of lift and distance of lift significantly impacted the perceived exertion level. In contrast, the weight, duration of lift, and angle of symmetry were insignificant. Some limitations of this study should be noted. First, the lifting task was conducted in a controlled laboratory. A real-working environment might produce a different result due to impacts from various factors. Another limitation is the small sample size of thirty-two participants. A larger sample size would give more accurate results. In addition, the participants were students with little or no work experience. Finally, only male participants were used for this study. Future studies could include female participation.

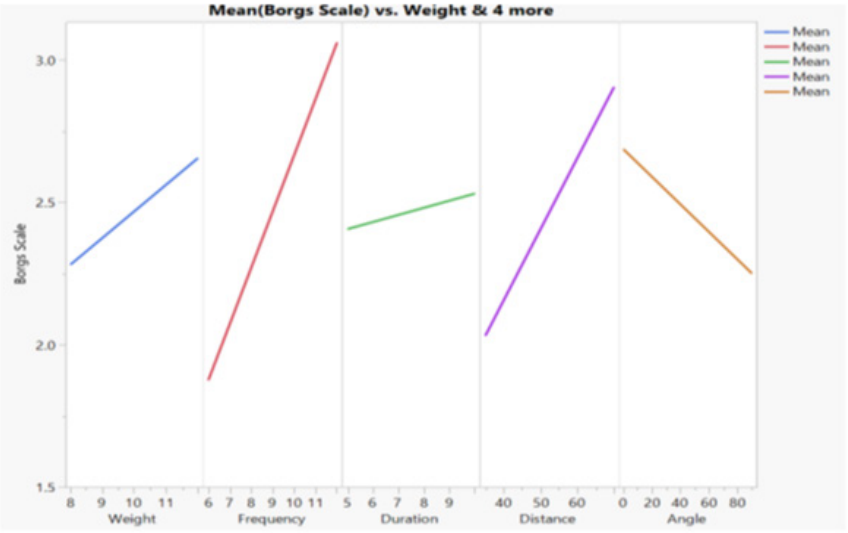

Figure 2: Means of Perceived Exertion vs. Lifting Parameters.

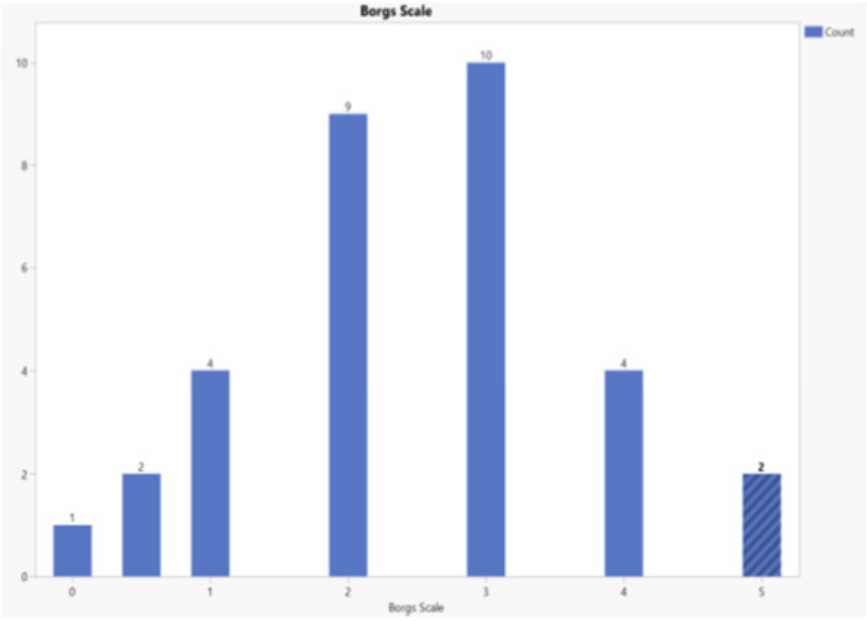

Figure 3: Frequency Distribution of Perceived Exertion.

Table 2: P-Values of the Variables.

Variable	p-value
Weight	0.36
Frequency	0.0039*
Duration	0.74
Distance	0.0277*
Angle	0.25

*Indicates significant variables.

Conclusion

This study found that the frequency and distance of the lift significantly affect workers' perceived exertion level. Increases in frequency and distance led to 62.76% and 43.35% increase in perceived exertion level, respectively. These findings emphasize the need to consider these lifting parameters when designing a lifting task to prevent work-related musculoskeletal disorders (WMSDs). However, further research in a real-working scenario with a larger and more diverse participation is needed to validate these results.

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