MUSCLE RECRUITMENT DURING SIMULATED PIECE PICKING TASKS COMMONLY PERFORMED IN DISTRIBUTION CENTERS

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INTRODUCTION

Bartholdi & Hackman (2014) suggest that order picking in a warehouse typically accounts for about 55% of the total warehousing operating costs. Thus, efforts exist to enhance order picker efficiency and ensure the accuracy of the types and quantities of products picked for customers' orders because the underperformance in order picking can cause high operation costs and have a negative effect on customer satisfaction (de Koster et al., 2007).

One-handed picking tasks are frequently performed when workers are picking small products or smaller quantities of products to fulfill customer orders. The items picked may include many of the products one can purchase at a pharmacy, for example individual bottles of shampoo. These individual items are often picked from boxes located on multi-level flow racks. The placement of the items on the flow racks, also know as slotting, can have a large impact on the efficiency of the operation as well as selector ergonomics and the risks for musculoskeletal disorders. Many slotting models have been developed that minimize travel distance based on individual item order frequencies. None of these models have considered the biomechanical costs associated with the item selection process. This project aimed to quantify the physical demands on the back and shoulders as participants performed simulated picking tasks from different shelf heights.

METHODS

In this study, 17 female participants lifted items of two different weights (0.45 and 0.90 kg) from seven shelf heights (10.8, 37.1, 63.5, 89.9, 116.2, 142.6, 168.9 cm) and either walked one step prior to picking up the item (lifting task 1) or lifted the item without needing to take a step (lifting task 2). Dependent measures included 90th percentile electro-myographic (EMG) signals from the anterior and lateral deltoid muscles, and the erector spinae muscles, as well as spine and shoulder kinematics, and task durations. _EMG data were normalized to maximal voluntary exertions.

RESULTS

The peak EMG activity of the anterior and lateral deltoid muscles reached the lowest values at the middle shelf heights (from 37.1 through 89.9 cm for the anterior deltoid, and 37.1 through 116.2 cm for the lateral deltoid). Significantly higher values were observed for both muscles once shelf height reached 142.6 cm and even higher values were observed at the 168.9 cm shelf height. Relative to the mid-level shelf heights, both of these shoulder muscles showed significantly more activity at the lowest shelf height (10.8 cm) as subjects reached out more during these low-level lifting conditions.

The left and right erector spinae muscles also shared a similar trend, in that both had significantly higher activation levels at the three lowest shelf heights. Both erector spinae muscles also had relatively low levels of activity that were not statistically different at shelf heights at and above 89.9 cm. Overall the EMG activity of the left, contralateral, erector spinae was higher than the right, ipsilateral, erector spinae at the three lower shelf heights because subjects lifted items with their right arm.

The peak EMG activity values of the anterior deltoid and the lateral deltoid muscles were higher for lifting task 2, in which no steps were required, than in lifting task 1 which required one meter of travel. In the second lifting task, depending upon where the subjects stood, they often needed to reach further to grab the second item than they did for the first item, thereby, creating a larger shoulder muscle exertion. However, the peak EMG activity levels of left erector spinae and right erector spinae muscles were not affected by the lifting task.

The results indicated that shelf height has significant effect on the time required to complete both task 1 and task 2. The time of complete task 1, with the one meter travel, is larger than the time to complete task 2 at each layer, and time difference between tasks is relatively consistent, the average of which is 0.75 seconds. The lifting time for shelf heights from 63.5 to 116.2 cm is relatively shorter compared with that at lower and higher shelves. The total time for walking and lifting varies by nearly half a second between the slowest and fastest conditions.

CONCLUSION

This study provides data that can be used to develop slotting guidelines for piece pick operations in distribution centers. Complimentary data are still needed for the full case replenishment tasks to ensure the ergonomic needs of those working the back side of the flow rack are also considered.

REFERENCES

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