

USE OF A PASSIVE BACK-SUPPORT EXOSKELETON IN LOGISTICS - TRANSFER OF LAB FINDINGS TO A REALISTIC WORK SETTING

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Introduction

Among work-related health problems, musculoskeletal disorders have the highest prevalence [1]. Back-support exoskeletons, such as the Auxivo LiftSuit, can help reduce strain on the back muscles during repetitive lifting tasks [2].

To understand how efficacy values obtained in controlled laboratory settings translate to actual work in different fields of application, it is important to collect data together with habitual exoskeleton users during real daily work tasks. This research project aims to collect biomechanical data with experienced exoskeleton users in various industries. Here we report data from a test conducted in a Carglass logistics warehouse.

Methods

Ten male logistics employees volunteered for the experiment. Participants wore the LiftSuit during their daily work prior to the experiment for a period ranging from 3 to 23 months. Muscular workload was assessed during five tasks, which are part of the daily operations in logistics: order picking accessories (items up to 12 kg), order picking heavy goods (items 12-20 kg), picking glass windows (Fig. 1), putting away glass windows, and quality control of incoming glass (a task involving prolonged forward leaning). Work with and without exoskeleton support (OFF/EXO) was recorded for a period ranging between 6 and 60-minutes depending on task duration. The protocol was approved by the ethics committee of ETH Zurich. Activity of the m. Longissimus in the lumbar region was recorded bilaterally using surface electromyography. The inclination of the upper body was recorded using an IMU placed on the spine at the level of T9. Muscle activity of periods of forward leaning and lifting sequences were selected using the IMU data.

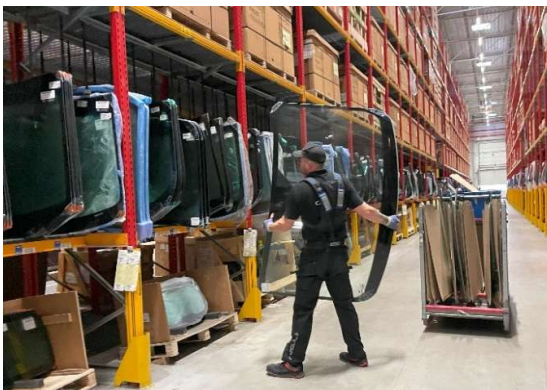


Figure 1: A participant picking glass windows while wearing the LiftSuit back-support exoskeleton.

Muscle activity was normalized to maximal voluntary contraction, and muscular effort was calculated as the area under the curve per second. The average of left and right is reported. Statistical analysis was performed using a Wilcoxon signed rank test to compare work with and without exoskeleton support.

Results

The lower back muscle activity varied between tasks, with an average across all tasks of 17.7%MVC when working without exoskeleton support (Fig. 2). The average muscular effort was 11.6%MVC when conducting the same tasks with exoskeleton support. A trend towards a reduction of 6.1%MVC, or 34% of the OFF condition was observed ($p = 0.08$).

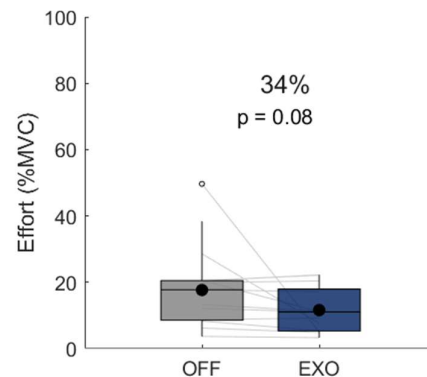


Figure 2: Muscular effort in the lower back while working with (EXO) and without (OFF) back support.

Discussion

The goal of this study is to quantify the support provided by the LiftSuit passive back-support exoskeleton during use in logistics by measuring back muscle activity under realistic conditions during a range of physically demanding tasks. The results show a trend towards a reduction in muscle activity during logistics work.

The observed reductions in back muscle activity in the field conditions were higher than previously reported in laboratory settings, where we previously reported a 12% reduction during forward leaning and a 21% reduction during repetitive lifting [2]. Participants in the laboratory study were novel to the exoskeleton, while participants in this experiment had extensive experience performing the measured tasks with exoskeleton support, which we hypothesize improves the support benefit they received.

References

1. Kok, et al. Publications Office of the EU, 2019.
2. Van Sluijs et al, J Biomechanics, 149:111489, 2023.

