

Effect of Low-Profile, Spring-Powered Exosuit on Back Muscle Fatigue during Leaning

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Wearable assistive devices can reduce lumbar muscle fatigue; however, most wearable devices are limited by practical factors such as affordability, form factor, and their ability to integrate into industrial workflows without interfering [1]. To address these limitations, we previously introduced a new spring-powered exosuit that combines the low-profile benefits of daily clothing with the physical assistance benefits of an exoskeleton [2]. **PURPOSE:** To evaluate the effect of this exosuit on lumbar muscle fatigue during leaning. **METHODS:** Six subjects (4 male, 2 female, 23.5 ± 1.4 yr., 69.6 ± 7.7 kg., 1.8 ± 0.1 m) performed leaning with vs. without lumbar torque assistance (12-16 N/m) from the exosuit prototype, while holding a 16 kg mass. Surface electromyography (sEMG) was recorded from six back extensor muscles: bilaterally on the lumbar multifidus (LM), longissimus thoracis (LT), and iliocostalis lumborum (IL). Individual muscle fatigue rate was calculated as the slope of the windowed (1-second epoch) median power frequency (MDF slope) of the bandpass filtered (10-500Hz) sEMG data. Individual muscle differences in MDF slope across conditions were evaluated using an analysis of covariance (F-test, $\alpha=0.05$). **RESULTS:** Five of six subjects exhibited significant reductions in MDF slope (ranging from 19-85%) in a subset of muscles with vs. without the exosuit (Fig. 1). Across all 6 subjects, the exosuit significantly reduced the fatigue rates for 20 of 36 muscles. **CONCLUSION:** We found that a spring-powered, clothing-like exosuit could significantly reduce the rate of lumbar muscle fatigue during leaning.

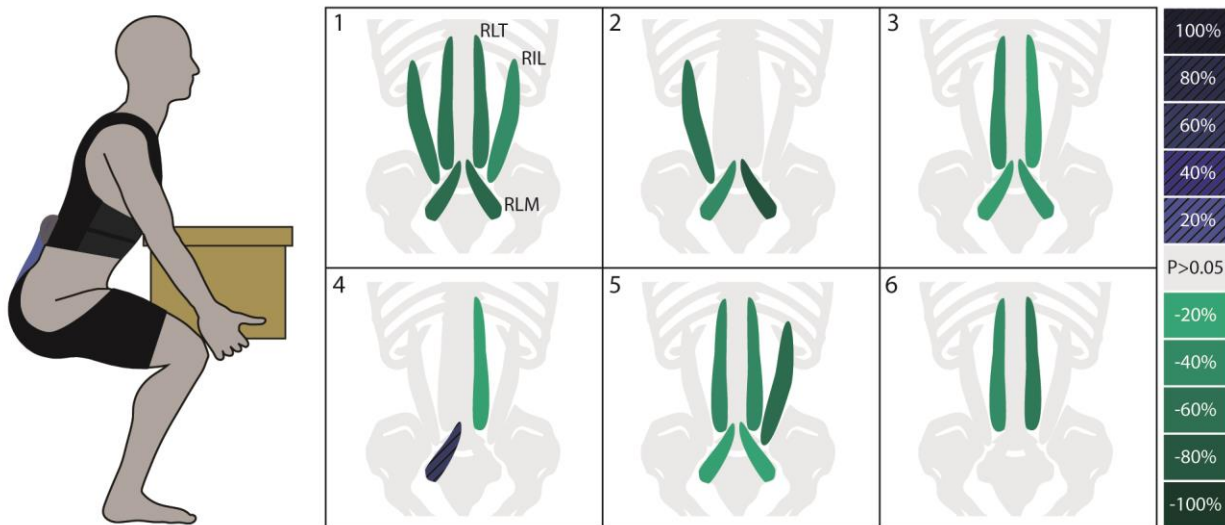


Figure 1: Subjects experienced reduced fatigue rates (green shading) for a subset of individual lumbar muscles (right) with lumbar torque assistance from the exosuit (left) vs. without assistance.

References

1. S.J. Baltrusch et al. (2018). *Applied Ergonomics*, **72**, 94-106
2. E.P. Lamers et al. (2018). *IEEE TBME*. **65**. 1674-80
3. A.F. Mannion et al. (1997). *JRRD*. **34**. 427-39