

EFFECTIVENESS OF WEARING AN EXOSKELETON DURING SME SPECIFIC WORK TASKS- PILOT TESTS RESULTS

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ABSTRACT

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1. INTRODUCTION

In Small and Medium Enterprises (SME) from logistics and manufacturing, physically heavy and variable work tasks are carried out. Exoskeletons could reduce the physical load but it needs to be investigated whether exoskeletons can adapt to the diversity of work tasks. Within the scope of the EU-funded program EXSKALLERATE, the use of lower back exoskeletons in SMEs is tested to study its effectiveness, acceptance and usability.

2. MATERIALS AND METHODS

One SME employee participated in pilot testing on-site and in a field laboratory. On-site, a real work scenario (commissioning products: lifting, carrying) was measured with XSENS with and without wearing a back exoskeleton. Biomechanical tests with XSENS (MVN, Xsens Technologies, Enschede, Niederlande) and EMG (Delsys Ltd. Europe) were conducted in the laboratory again, with and without wearing a back exoskeleton. In the field laboratory lifting (12,5kg), carrying (12,5kg) for 6m and a sorting task in forward bend position were tested. The Paexo Back from Ottobock was used for the tests. Trunk muscles and muscles from lower extremity were derived. A previously developed measurement protocol for field laboratory tests was followed. XSENS data was analysed with Industrial Athlete (scalefit UG, 2019.4.18.4260) and EMG data was further processed in MATLAB (9.9.0.1538559 (R2020b)) where it was filtered (Butterworth and RMS) and analyzed. With

the BORG CR10 scale, subjective feedback was retrieved.

3. RESULTS AND DISCUSSION

On-site

The exoskeleton could minimize the load on the lower back while commissioning (Fig. 1) which was also shown in subjective data.

Although the exoskeleton was comfortable to wear it showed to be inconvenient for some of the occurring work tasks. Forklift driving and working in confined areas proved the exoskeleton to be impractical.

Field laboratory

Lifting and carrying with the exoskeleton reduced the disc compression on segment L5/S1 (Fig. 2 and Fig. 3). Overall muscle activity was reduced or not increased (Fig. 4). Mean subjective load was reduced when wearing the exoskeleton.

The Paexo Back can be used in SME although work processes have to be adapted. It reduces load on the lower back through decreased muscle activity. During EMG data evaluation it became apparent that the exoskeleton presses on some of the EMG sensors which results in noisy data. It is currently trialed if small 3D printed boxes protect the sensors underneath the exoskeleton.

4. CONCLUSION

In this pilot test the exoskeleton could relieve the wearer in this specific work task. Best effects can be achieved when work processes are adapted. Further studies need to investigate different work tasks and SMEs. Measuring EMG while using an exoskeleton is not trivial and needs further testing.



Figure 1: On-site testing, commissioning. Top: trunk inclination; middle: disc compression NoExo; bottom: disc compression wearing Paexo Back

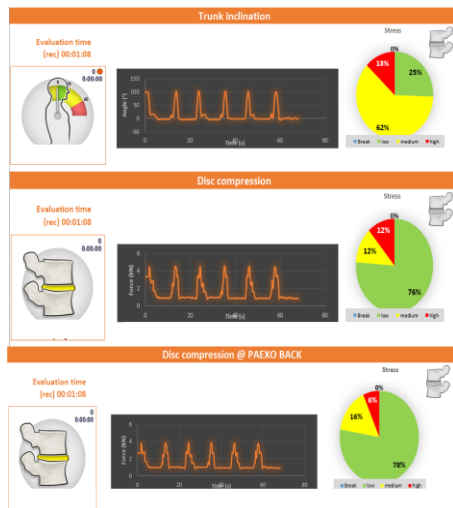


Figure 2: Field laboratory testing, lifting 13kg. Top: trunk inclination; middle: disc compression NoExo; bottom: disc compression wearing Paexo Back

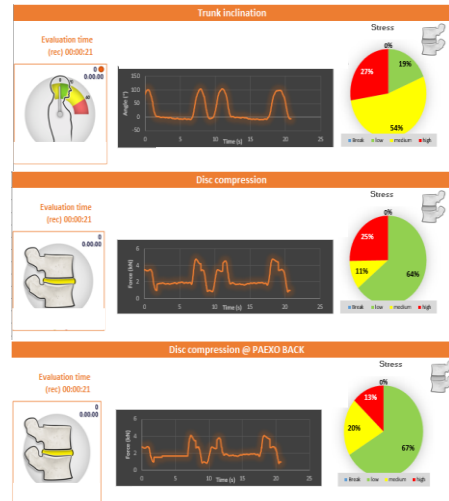


Figure 3: Field laboratory testing, carrying 13kg. Top: trunk inclination; middle: disc compression NoExo; bottom: disc compression wearing Paexo Back

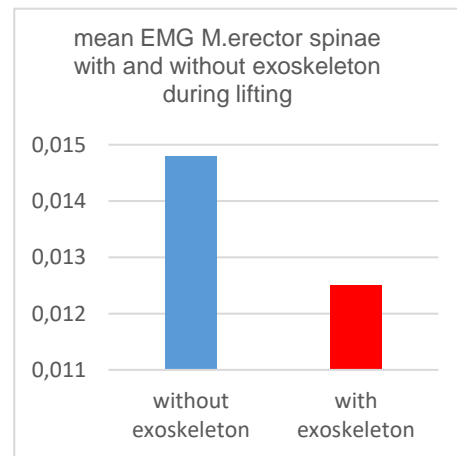


Figure 4: mean EMG activation of M. erector spinae lifting 13kg with and without wearing back exoskeleton