WearHealth®

IMPACT ASSESSMENT REPORT

EXOSKELETTER DK
INDUSTRI - BYGGERI - PRODUKTION - LOGISTIK

Executive Summary

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STUDY EXOSKELETON

Company: **AUXIVO**

Model: **LIFTSUIT**

Support area: **Back**

Type: **Passive**

DATA COLLECTED

August 2022

NO EXO	WITH EXO
1 Day	1 Day
2 Tasks	2 Tasks
1 User	1 User

Main results

LOWER BACK DISORDER (LBD) RISK REDUCTION

▼13%

LBD risk reduction

Potential reduction in lower back disorder risk (LBD) using the exoskeleton.

EXOSKELETON / TASK FIT

	Task 1 Digging	Task2 Weeding
Ergonomic Risk (LOW, MODERATE or HIGH RISK)	HIGH	MODERATE
LiftSuit Fit	✓ GOOD	✓ GOOD

POSTURAL BEHAVIOUR IMPACT

▼93%

High risk bending

▼42%

High risk lifts

Reduction in postural risks using the exoskeleton.

PHYSIOLOGICAL IMPACT

▼17%

Workload

▲14%

Recovery

Physiological impact using the exoskeleton.

RECOMMENDATIONS

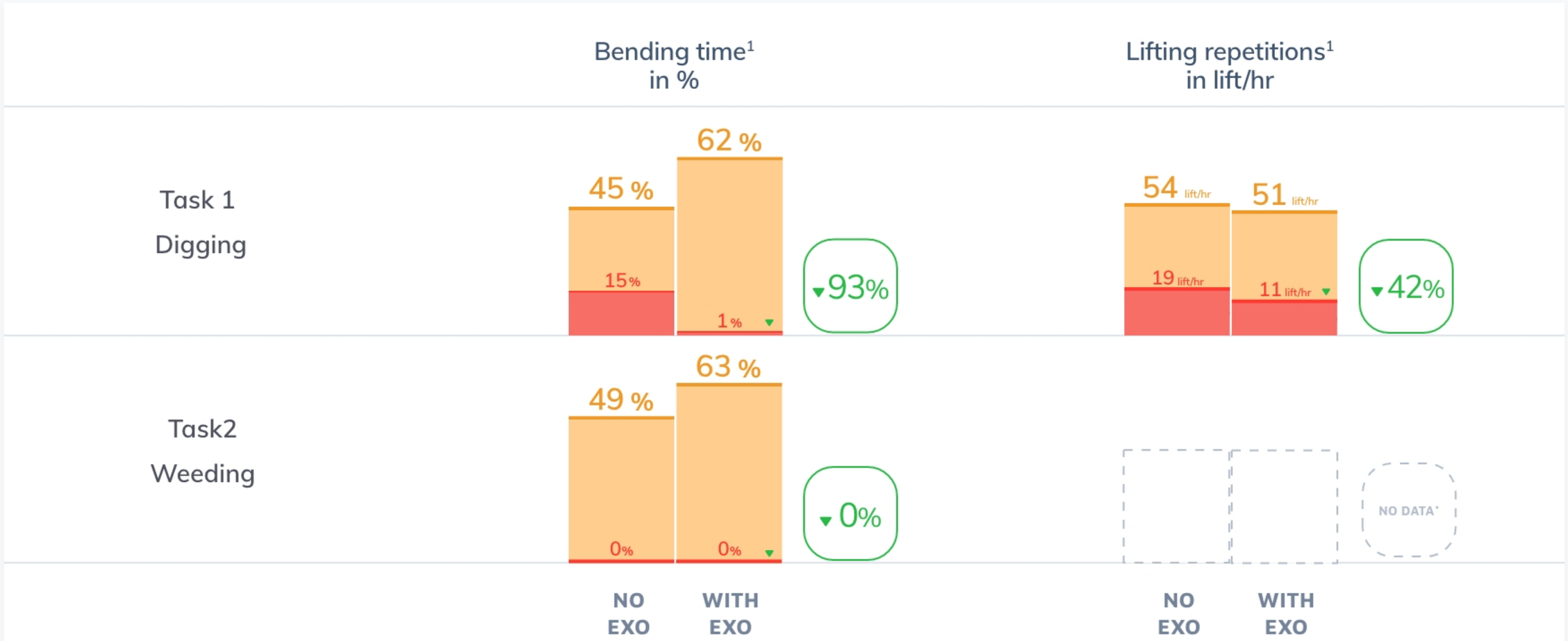
→ **Follow a stepwise implementation & evaluate with additional data**

Considering back flexion risks, the analysed activities have moderate to high ergonomic risk. The use of the exoskeleton **LiftSuit** may reduce the risk of developing a low back disorder (LBD). It **could potentially reduce LBD risk in 13%**. Besides, **LiftSuit may lead to bending and lifting posture improvement**, data has shown a reduction of 93% of high risk bending and 42% of high risk lifts. Furthermore, there was a **reduction of 17% in workload and an increase in 14% on time spent in recovery zone**.

These results should be interpreted as preliminary because they are based on a small sample size. Therefore, periodic evaluation with additional data is recommended.

Main ergonomic results

TASK PROFILE



[1]Average bending in a moderate, high or very high ergonomic postural risk index (Moderate 20° - 60° | High 60° - 90° | Very High > 90°).
*Data was not sufficient for the calculations.

ERGONOMIC ASSESSMENT

	Back Ergonomic Risk[2]	
	NO EXO	WITH EXO
Task 1 Digging	HIGH	MODERATE
Task2 Weeding	MODERATE	MODERATE

[2]Based on RULA ergonomic assessment (more on page 6)

→ With exoskeleton, the back ergonomic risk from Task 1 decreases from high to moderate due to changes in the bending angles that lead to a decrease of postural risk.
The ergonomic assessment does not encompasses all possible risks, only back flexion related risks.

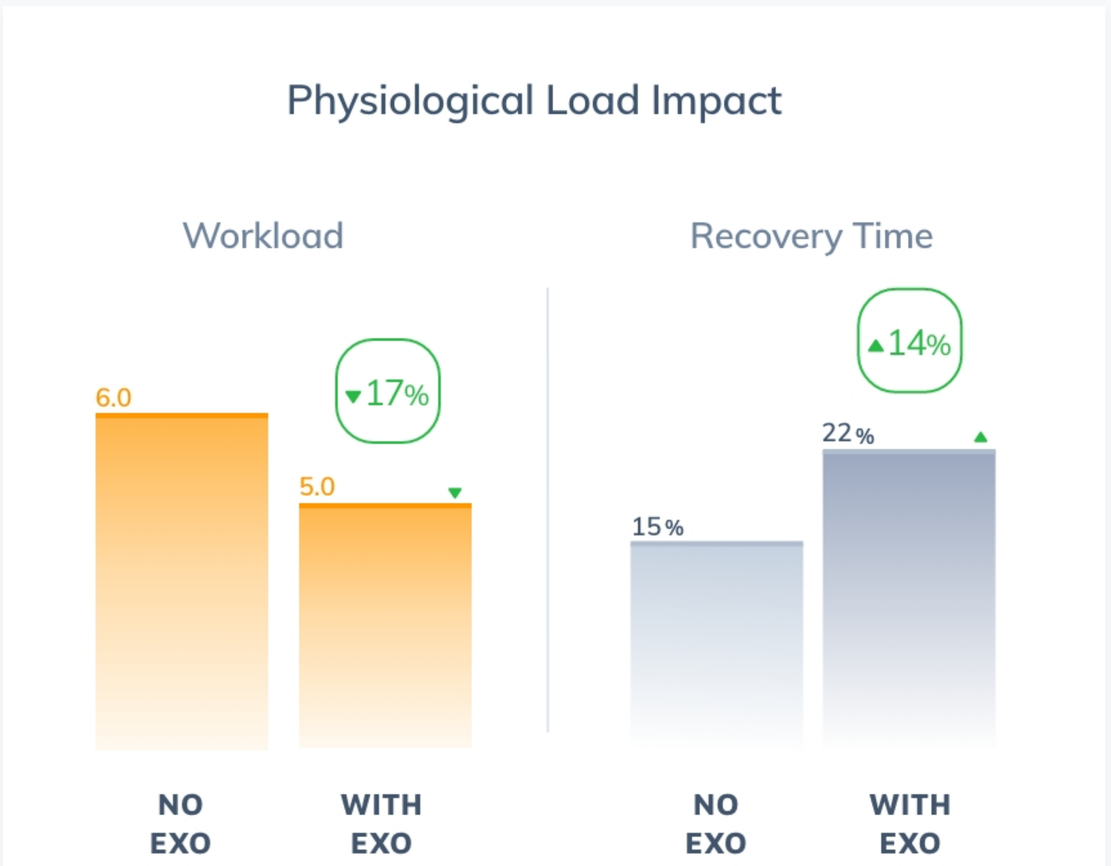
LOWER BACK DISORDER (LBD) RISK REDUCTION

	Task LBD Risk Reduction	Workday LBD Risk Reduction
Task 1 Digging	13%	13%
Task2 Weeding	19%	

→ Potential reduction in lower back disorder risk using the exoskeleton. Calculated with Exo-LiFFT ergonomic assessment, which is based on the motion profile of each task and the theoretical exoskeleton support

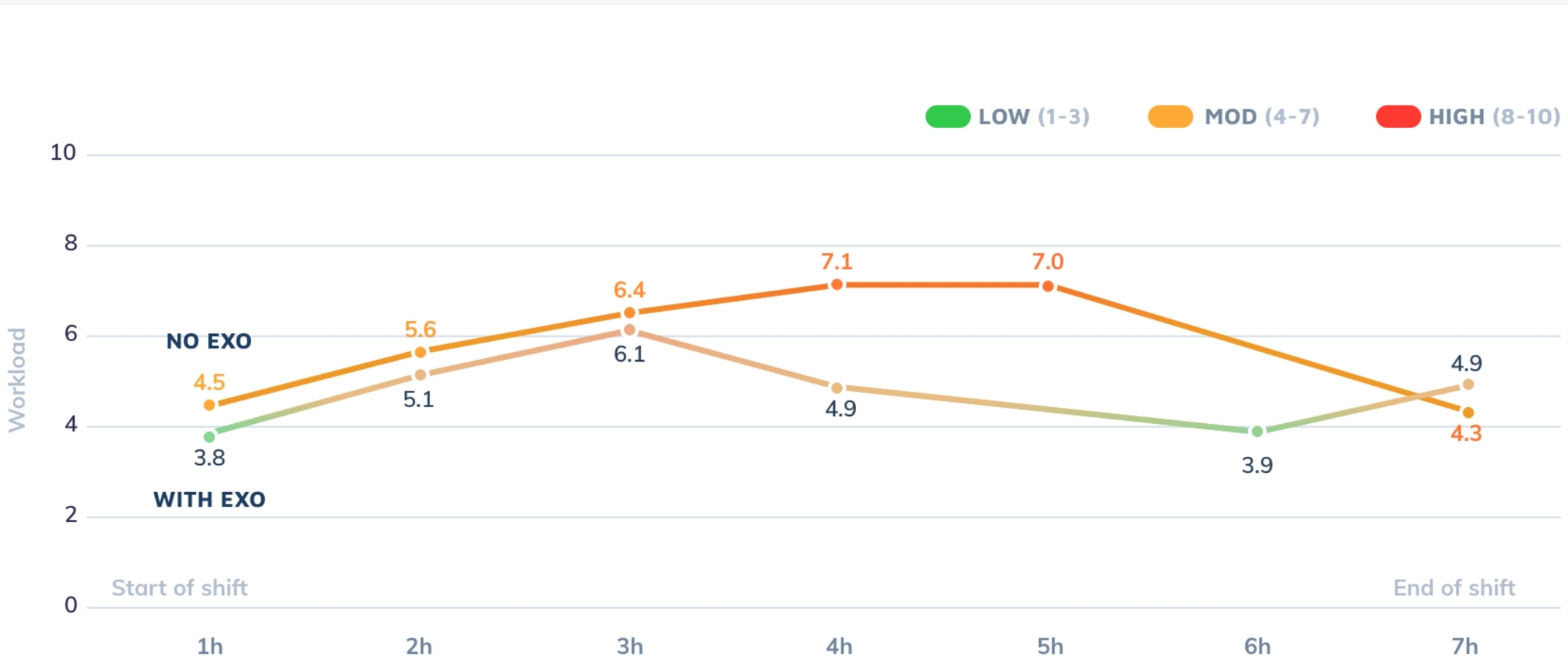
Main physiological results

WORKLOAD & EXERTION



PHYSIOLOGICAL ANALYSIS BY TASK

WORKLOAD EVOLUTION



MAIN FINDINGS

→ From a physiological perspective, the exoskeleton LiftSuit showed that it could be an effective way to reduce the physical load during the operations carried out during the study. Overall, the exoskeleton showed positive results in terms of Workload reduction (-17%) and increase in Recovery (+14%) across the different operations.

CONSIDERATIONS

General limitations

Study sample size

The results should be interpreted with caution because they are based on a small sample size, meaning that confounding factors could have had a large impact on the results.

Partial task segmentation

The operations carried out were segmented by tasks, but either not all tasks were monitored with the exoskeleton or the data was not complete; so the final results could include resting periods or mix different tasks where the exoskeleton provided different levels of support.

Lack of user feedback

When it comes to implementing exoskeletons, usability, comfort, and user-perceived support are very important factors. Unfortunately, the current study did not have access to such information for all tasks for all exoskeletons, so generalized comparisons may have confounding factors.

Ergonomic risk assessment

Assessment considerations

The ergonomic assessment does not encompasses all possible risks nor all body parts. This should be taken into consideration when interpreting and results should be considered as preliminary.

Low back disorder (LBD) risk

LBD risk is calculated using Exo-LiFFT ergonomic assessment tool. Which is based on the motion profile of each task and the theoretical exoskeleton support.

Karl E. Zelik, Cameron A. Nurse, Mark C. Schall, Richard F. Sesek, Matthew C. Marino, Sean Gallagher, An ergonomic assessment tool for evaluating the effect of back exoskeletons on injury risk, Applied Ergonomics, Volume 99, 2022, 103619, ISSN 0003-6870

Motion & force analytics

Estimations for torque (forces)

Some variables such as the distance from the low back to the load are not measured directly, and thus, are based on estimations.

REFERENCE STANDARDS

ATSM
F3474 – 20 ; F3518 – 21

ISO
6385:2016; 10075-1:2017; 10075-2:1996; 10075-3:2004; 8996:2004; 11226:2000

Annex - Ergonomic Profiling

RAPID UPPER LIMB ASSESSMENT (RULA)

Risk level	Rating criterion	Score
NO RISK	No action required if posture is not maintained or repeated for long periods	1 - 2
LOW RISK	Further investigation is needed and changes may be required	3 - 4
MODERATE RISK	Further investigation and changes are required soon	5 - 6
HIGH RISK	Further investigation and changes are required immediately	+ 6

RULA (or Rapid Upper Limb Assessment) is a task-level assessment tool used to evaluate biomechanical and postural load requirements of job tasks/demands on the upper extremities, neck, and trunk.

Sources

Gómez-Galán, M.; Callejón-Ferre, Á.-J.; Pérez-Alonso, J.; Díaz-Pérez, M.; Carrillo-Castrillo, J.-A. Musculoskeletal Risks: RULA Bibliometric Review. Int. J. Environ. Res. Public Health 2020, 17, 4354. https://doi.org/10.3390/ijerph17124354

Roman-Liu, D., 2014. Comparison of concepts in easy-to-use methods for MSD risk assessment. Applied ergonomics 45, 420e427.

Lynn McAtamney et al., "RULA: a survey method for the investigation of world-related upper limb Disorders," Applied Ergonomics, 1993

EXO-LIFFT

Exo-LiFFT is an ergonomic assessment tool that unifies the etiology of lower back disorders (LBD) and biomechanical function of exoskeletons. It can be used to assess or predict the effect of exoskeletons on LBD risk without EMG testing.
The table below shows examples of simple prediction results. Reductions in LBD Risk are shown for different exoskeleton assistance and object weights.

	Light Objects (5 kg)	Moderate Objects (12 kg)	Heavy Objects (19 kg)
Strong exo assist (35Nm)	N/A	27%	20%
Moderate exo assist (25Nm)	22%	20%	15%
Mild exo assist (15Nm)	15%	12%	8%

Source

Karl E. Zelik, Cameron A. Nurse, Mark C. Schall, Richard F. Sesek, Matthew C. Marino, Sean Gallagher, An ergonomic assessment tool for evaluating the effect of back exoskeletons on injury risk, Applied Ergonomics, Volume 99, 2022, 103619, ISSN 0003-6870

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