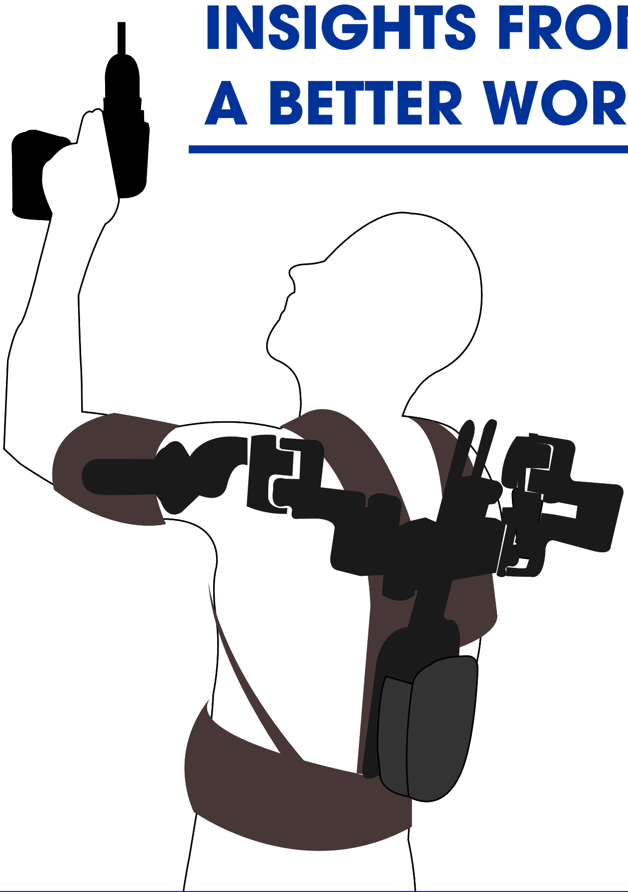
YOU ARE KINDLY INVITED TO THE PUBLIC DEFENSE OF THE DISSERTATION OF

SANDER DE BOCK

SUBMITTED TO OBTAIN THE ACADEMIC DEGREE OF
DOCTOR IN MOVEMENT AND SPORT SCIENCES

OCCUPATIONAL EXOSKELETONS: INSIGHTS FROM THE LAB TO CREATE A BETTER WORKING ENVIRONMENT



WEDNESDAY, OCTOBER 26TH 2022 AT 17:00
ROOM D2.01, CAMPUS ETTERBEEK (more info here)

SUPERVISORS
Prof. dr. Kevin De Pauw (VUB)
Prof. dr. Romain Meeusen (VUB)
Dr. Joost Geeroms (VUB)

EXAM COMMISSION
Prof. dr. Nele Adriaenssens (VUB) - Chair
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Prof. dr. Tom Verstraten (VUB)
Prof. dr. Heike Vallery (TU Delft)
Prof. dr. Massimo Sartori (UTwente)

After this defense, you are welcome at the reception.
Please confirm your presence HERE **before 21/10**.
Click HERE to join online (MS Teams).

VUB MFYS HUMAN PHYSIOLOGY & SPORTS PHYSIOTHERAPY RESEARCH GROUP
VUB BRUBOTICS HUMAN ROBOTICS RESEARCH CENTER
VUB PHYSICAL EDUCATION & PHYSIOTHERAPY

ABSTRACT OF THE RESEARCH

Work-related musculoskeletal disorders (WMSDs) are still highly prevalent in the occupational context, despite ongoing efforts. Since excessive physical workload has been linked with these WMSDs, ergonomists search for opportunities to reduce the physical workload on workers without disrupting the company's workflow.

Occupational exoskeletons, wearable assistive devices, have the potential to reduce the workload while retaining the flexibility and dexterity of the worker. Overall, exoskeletons seem to reduce the acute physical strain acting on the worker, but the comprehensive research companies demand before considering exoskeleton implementation on large scale is still lacking. In the first part of this thesis, a literature-based framework was proposed to facilitate benchmarking the effect of occupational exoskeletons on the user. While the vast variability of exoskeleton assessment protocols is certainly valuable, this framework provides guidelines to design future assessment protocols. Over time, this framework can improve comparability among exoskeleton assessment studies, which will facilitate extracting a consensus from the available literature.

Most exoskeleton assessments have been performed in laboratories. How exoskeletons affect the workload in the field, and how those laboratory-based results compare to the effect in the field, was explored in the second part of this thesis. The effect of the exoskeletons observed in the field was weaker compared to the effect observed in a controlled environment. Although the sample size of this exploratory study was limited, I concluded that the effect of current passive shoulder exoskeletons is context-dependent, and laboratory studies tend to mainly focus on the target area of the exoskeletons while real occupational tasks are more versatile. To improve the transfer of results obtained in laboratories to the field, future laboratory studies could better mimic real-life situations.

During the FWO-SBO research project I was involved in, a new passive shoulder exoskeleton, Exo4Work, was developed. The last part of this thesis contains two randomized controlled trials where the effect of this exoskeleton prototype on the user was investigated. This exoskeleton aims to assist the shoulder joint during overhead work. Apart from reducing physical shoulder load during overhead work, this device was designed to address some of the remaining challenges of current passive shoulder exoskeletons, i.e. allowing the user to move naturally, and maximally avoiding hindrance. Providing a relatively low amount of support reduced anterior deltoid activity up to 16%, and attenuated development of muscle fatigue. When lowering the arms, or when performing non-overhead work, the hindrance of the exoskeleton was limited. Without the support of the exoskeleton, participants started to use compensatory movements in the upper body when they were fatigued, but the support of the exoskeleton partially mitigated this undesired effect. Despite these acute load-relieving effects, participants did not perceive working with the exoskeleton as lighter or easier. Based on these results, it was concluded that this exoskeleton can be tested in the field, preferably in a longitudinal experimental setting.

This Ph.D. thesis provided a benchmarking framework for occupational exoskeleton assessment and showed that current laboratory-based results should be transferred to the field with caution. The Exo4Work exoskeleton has the potential to reduce physical load at the shoulder during overhead work. Additionally, hindrance during non-overhead work was limited, which could facilitate acceptance of the exoskeleton. Future work should investigate which parameters affect the perception of workload of the wearer to further increase usability and acceptance of the exoskeleton in the field.

CURRICULUM VITAE

2012 - 2017	Master of Science in Physical Education and Movement Sciences (UGent)
2018 - 2022	Ph.D. candidate (VUB)
2018 - current	Teaching students in Rehabilitation Sciences and Physiotherapy, and Movement and Sports Sciences (VUB)
2017 - current	(Inter)national presentations
2019 - current	(Co-)author of 16 peer-reviewed scientific publications

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