Occupational exoskeletons for preventing work-related musculoskeletal disorders: A review of the state-of-the-art and a road map for future research

Invited Lectures

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Work-related musculoskeletal disorders (WRMSDs) due to overexertion are one of the most prevalent and costly sources of nonfatal occupational injuries, accounting for over 1/3rd of total annual cases in many countries worldwide, with the back and shoulder being the most affected body regions. In this context, exoskeletons – wearable devices that augment a user's physical capacity and/or reduce physical demands – are emerging as a promising intervention to attenuate physical demands, potentially reducing fatigue and the risk of occupational injuries. State-of-the-art evidence on the effectiveness of exoskeleton interventions will be presented using a combination of relevant biomechanical, psychophysical, and psychosocial outcome measures. Laboratory-based evidence on the functional effectiveness of passive arm-support and back-support exoskeletons in terms of back and shoulder muscle activity, kinematics, and lumbar spine loading will first be summarised. This will be followed by age- and gender differences in psychophysical outcomes (maximum acceptable workload) when using passive back-support exoskeletons to perform simulated manual material handling tasks. Despite growing evidence from laboratory studies, exoskeleton technologies are still not implemented widely in work settings due to various challenges with technology usability, worker acceptance, workflow and work-environmental concerns, and organisational policies. Research on these factors affecting practical implementation will be summarised. Finally, several unanswered questions about the longer-term consequences of prolonged exoskeleton use include measures of MS symptoms, applicability to diverse workers and work sectors, and cost-benefit analyses. These will be discussed to propose a framework for occupational implementation and a roadmap for future research.