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## **Advancing healthy aging in times of sustainability: The role of lower-limb exoskeletons in gerontechnology**

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**Purpose** Anchored in the World Health Organization's perspective on aging—which advocates for the preservation of functional abilities essential for well-being in later life—this review scrutinizes the role of intrinsic capacity (IC), spanning cognitive, psychological, locomotor, sensory, and vitality dimensions. Moreover, it considers the environmental dynamics that shape older adults' operational capabilities. Amidst global challenges, such as demographic shifts and healthcare crises, the mobility of older adults emerges as a pivotal concern. This review seeks to fill the research void on the comprehensive effects of LLE on IC and functional abilities, evaluating how LLE technology can support active aging, mitigate injury risks, and foster a more autonomous community of older adults in the face of sustainability and crisis challenges. It aims to unfold the capacities of LLE interventions to revitalize IC, enhance functional abilities, and navigate the complexities of aging, thereby offering insights into the expansive utility of LLE beyond conventional rehabilitative and assistive scopes. **Method** This systematic review, registered in PROSPERO (CRD42023434655) and adhering to PRISMA 2020 and the Cochrane Handbook, employed a comprehensive search across PubMed, EMBASE, Web of Science, and other databases in June 2023, targeting studies on the use of lower-limb exoskeletons (LLE) in older adults to enhance functional ability and intrinsic capacity (IC). The search included a wide range of study designs, settings, and populations, focusing on individuals aged  $\geq 50$  years, with a mean age of  $\geq 65$  years, without limiting health conditions, exoskeleton types, or intervention specifics. Studies were screened and data extracted using EndNote X9 and Rayyan QCR1, with inclusion determined by two independent researchers and disputes resolved by a third. Data on study design, outcomes, and participant demographics were systematically collected. The extracted information was categorized based on the WHO's vision on healthy aging into IC and functional ability, with a further subdivision for performance indicators within the IC domain. The methodological quality of included studies was evaluated using the Downs and Black Scale, classifying studies from excellent to poor. **Results and Discussion** The systematic review analyzed 36 articles, highlighting the diverse application of lower-limb exoskeletons (LLE) in enhancing functional abilities, intrinsic capacities (IC), and performance indicators in older adults across various health conditions. Methodological quality varied, with 22.2% rated as poor, 55.5% as fair, and the remaining 22.2% as good. Studies spanned multiple conditions, including stroke, Parkinson's Disease, osteoarthritis, and more, with significant positive outcomes in mobility, functional abilities, and various performance measures. Specifically, improvements were noted in mobility measures across different conditions, with varied efficacy depending on the health issue and the type of LLE used. Additionally, the review revealed enhancements in IC through LLE interventions, demonstrating improvements in locomotor capacity and vitality, among others. The analysis also underscored significant gains in performance indicators, such as walking speed and endurance, underlining the potential of LLE to support healthy aging and rehabilitative efforts across a broad spectrum of older adults. While longer intervention durations can aid in the rehabilitation of intrinsic capacities, even instantaneous augmentation of functional abilities can be observed in a single session.

**Keywords:** healthy ageing, lower-limb exoskeletons

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**Acknowledgement:** This work was supported by the strategic basic research project RevalExo (grant no. S001024N) funded by the Research Foundation – Flanders (FWO). Mahyar Firouzi is a Fundamental Research fellow funded by the Research Foundation Flanders (FWO, award number 11G9622N)