PUBLIC PHD DEFENCE FOR THE DEGREE OF
DOCTOR IN REHABILITATION SCIENCES AND PHYSIOTHERAPY

HUMAN-PROSTHETIC INTERACTION IN INDIVIDUALS WITH LOWER LIMB AMPUTATION: A CLINICAL PERSPECTIVE

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MONDAY, MAY 19TH 2025 AT 17:00
ROOM I.0.01, CAMPUS ETTERBEEK

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ABSTRACT OF THE RESEARCH

Lower limb amputation, often due to injury, disease, or congenital conditions, severely impacts physical function and psychosocial health, diminishing the individual's quality of life. Prostheses are designed to restore functional capacity, with advancements moving from passive to quasi-passive and active prostheses to reduce adverse effects. However, no comprehensive overview currently exists on the impact of different ankle-foot prostheses on quality of life.

This dissertation stems from the Talaris project, a research initiative funded by Innoviris that fosters collaboration between Vrije Universiteit Brussel and the Brussels company Axiles Bionics. As part of this project, Axiles Bionics developed the Talaris Demonstrator (TD), a passive ankle-foot prosthetic prototype, which later evolved into the Lunaris prosthetic foot, the commercial product based on the TD.

The dissertation addresses two key needs: first, a comprehensive evaluation of the short- and long-term effects of ankle-foot prosthetic technology on quality of life, incorporating performance-based, biomechanical, physiological, and psychological measures; and second, a clinical evaluation of the prostheses developed by Axiles Bionics. The objectives were: §1 to identify the therapeutic benefits of ankle-foot prostheses for individuals with unilateral lower limb amputation (Chapter 2); §2 to evaluate the performance of individuals using the TD compared to their current prosthesis through standard laboratory tests (Chapter 3); §3 to assess differences in oxygen consumption, perceived fatigue, and comfort between the TD and current prostheses (Chapter 3); §4 to examine differences in walking patterns between users of the TD and their current prosthesis (Chapter 4); §5 to develop a protocol for assessing neuroplasticity differences between individuals wearing a passive ankle prosthesis with an articulated joint versus a standard passive prosthesis, and to investigate neuroplastic changes within these groups (Chapter 5); §6 to establish a protocol to study the influence of the type of prosthesis on walking performance and quality of life, and determine whether the type of prosthesis induces differences in gait patterns (Chapter 5).

In the systematic review (Chapter 2), it was found that most outcome measures per study show predominantly short-term positive results for biomechanical, physiological, performance-related, or subjective outcomes for more advanced prostheses, implying therapeutic benefits for those walking with them. However, all studies also identified both no effects and unfavourable effects for these devices. No articles included long-term evaluation studies. The review highlighted the need for both short- and long-term studies comparing active, quasi-passive, and passive prostheses, with more emphasis on subjective measures like comfort and satisfaction. Additionally, the review demonstrated the need for further research on how different prostheses affect brain neuroplasticity. The evaluation of the TD (Chapter 3) using physiological, performance-based, and subjective measures found no significant differences in heart rate, oxygen consumption, or perceived exertion compared to the individuals' current prostheses during clinical tests. However, slope walking suggested a potential advantage in perceived comfort, warranting further investigation. The biomechanical analysis (Chapter 4) showed differences in coordination patterns during treadmill walking, emphasizing the need to explore adaptive strategies used by individuals with amputations. In Chapter 5, a unique long-term study protocol was developed to examine brain activity while concurrently assessing the prosthetic device's impact on individuals with amputation based on performance, subjective, and biomechanical measures.

Despite prosthetic advancements, this dissertation highlights ongoing challenges in conducting prosthetic evaluation studies, such as the lack of standardised evaluation protocols and limited prosthetic familiarisation time, which impact the interpretation and validity of results. The ultimate aim of prosthetic research is to improve individuals' quality of life. In this regard, and based on this dissertation, future directions should include further in-dept evaluation of the prosthetic devices and assessing the impact of the different prosthetic devices on brain neuroplasticity to improve prosthetic selection and rehabilitation strategies. As technology evolves, the future of prosthetics holds great promise but will require continuous innovation, multidisciplinary collaboration, and patient-centred care.

CURRICULUM VITAE

Elke Lathouwers is a doctoral candidate at the Human Physiology and Sports Physiotherapy research group. She obtained her Master of Science in rehabilitation sciences and sports physiotherapy in 2021 at the Vrije Universiteit Brussel. Subsequently, she initiated her PhD as a researcher in the Innoviris Talaris project focusing on the holistic evaluation of prostheses in people with a lower limb amputation.