Real-world walking speed assessment: Opportunities and challenges
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Purpose There is growing consensus that walking speed (WS) can be considered as a functional 'vital sign' since it was used as a predictor and outcome measure across multiple diagnoses (Fritz & Lusardi, 2009). Today advances in wearable sensor technology, associated with appropriate data analysis algorithms, are leading the transition from laboratory-based to pervasive real-world assessment of WS. From a clinical perspective, the reliable assessment of WS in everyday life context and across various clinical populations may open new perspectives, as for example early detection and prevention of functional decline, and/or as a clinical outcome for more personalised treatments/interventions. The monitoring in real-life context poses however technical challenges, as for example development of algorithms based on a single body worn sensor (for patient comfort), that are accurate and robust in various clinical and contextual conditions. **Methods** Study 1: A new technically validated algorithm for real-world walking bout (WB) detection and WS estima-tion using a single wrist-worn sensor (Soltani, Dejnabadi, Savary & Aminian, 2019; Soltani, Paraschiv-Ionescu, Dejnabadi, Marques-Vidal & Aminian, 2020), has been applied for further clinical validation to a cohort dataset (CoLaus, n.d.), including N=2809 subjects wearing a wrist accelerometer during 2-weeks/person. Study 2: A systematic review has been conducted to identify state of the art algorithms for WB detection and WS estimation using a single low-back-worn sensor. We identified the various methodological challenges (e.g., impaired gait pattern, walking context), implemented the algorithms in original (as published) and improved versions (proposed by MobiliseD consortium (Mobilise-D, n.d.; Paraschiv-Ionescu, Soltani & Aminian, 2020)), and evaluated them comparatively on various datasets with the aim to select the most promising for further clinical validation in the context of MobiliseD project (Mobilise-D, n.d.). **Results & Discussion** Study 1: Analysis results showed that aging, obesity and adverse events led to a reduction of walking speed and cadence, a trend consistent with the clinical observation. The methodology developed appears very promising, given that it is based on a wrist-worn sensor which provides high compliance of people, crucial for long-term measurements. However, more extensive evaluations of the algorithm on various populations (slow walkers, pathological gait) are necessary. Study 2: Theoretically, a sensor located close to the body's centre of mass allows a more reliable assessment of the gait pattern and related parameters as compared to a wrist-located sensor. However, the performances of current existing algorithms degrade considerably when applied on pathological/heterogeneous gait patterns in an every-day life context. Although more advanced processing of raw acceleration data (e.g., filtering, feature enhancement) allow significant performance improvement (Paraschiv-Ionescu, Soltani & Aminian, 2020), more extensive evaluation in challenging conditions is necessary before using the estimated WS as a clinical outcome. There is currently a significant research effort to develop robust algorithms for real-world WS estimation – a mobility parameter to be used as a reliable outcome measure in clinical practice (Mobilise-D, n.d.).

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