The Applicability of Smart Wearable Devices Among Individuals with Neurological Disorders

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BACKGROUND

- **Smart wearables** are electronic hands-free devices worn externally on the body to monitor **physical, physiological, and psychosocial parameters**.
- **Commercially** available smart wearables (e.g. watches such as Fitbit, Apple, etc.) are designed to track parameters in the **healthy population**.
- These devices may face reliability challenges when used by individuals with conditions such as stroke-related hemiplegia or spinal cord injuries requiring wheelchair use.
- **Objective:** To conduct **a scoping review** to map all evidence pertaining to the **applicability** of **smart wearables** in monitoring physical activity, physiological and psychosocial parameters in individuals with **neurological disorders**.

METHODS

Population	Adults with neurological disorder(s).
Concept	Smart wearables: Electronic hands-free devices worn externally on the body to monitor activities.
Context	Monitoring daily life physical, psychosocial, or physiological parameters

Table 1. Population, Concept and Context (PPC) framework for scoping reviews.

Search Strategy

- Databases: PubMed, EBSCOHost, Cochrane Library, IEEEXplore and Web of Science.
- Search terms: “wearables”, “neurological disorders” and “applicability” (+variations).

Eligibility Criteria

- Inclusion criteria: 1) Adults (18+ years) with neurological disorders; 2) Publications from Jan 2004-Aug 2024; 3) Use of wearable technology for monitoring or treatment.
- Exclusion criteria: Studies using implanted sensors or prototype wearable devices.

RESULTS

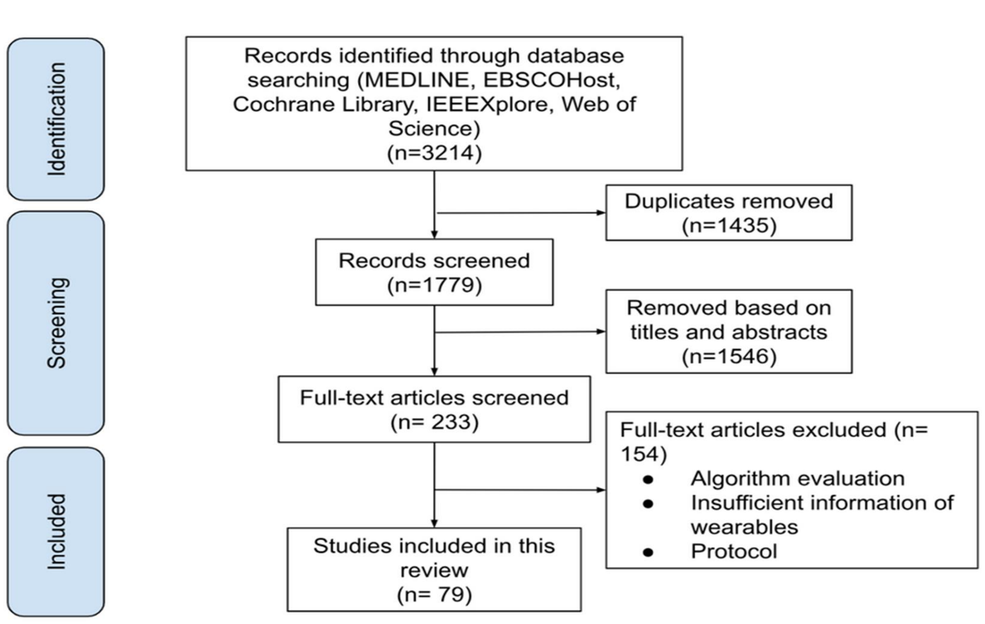


Figure 1. PRISMA flowchart

- **31** studies targeted **upper limbs** (25 on physical activity, 15 on physiological, 3 on psychosocial). Smartwatches dominated, mostly tracking arm use and gait. In Parkinson’s disease, wearables effectively detected motor fluctuations (e.g. tremors).
- **13** studies focused on **lower limbs**, using only commercial devices to assess physical activity, including balance (e.g. postural sway) and fall risk.
- **15 studies** used **trunk-worn** devices (8 for monitoring, 6 for assessment, 1 for intervention), mostly capturing physical (n=11), physiological (heart rate, motor states; n=3), and psychosocial (mobility; n=1) metrics.
- Most studies were **lab-based**, **limiting** insights into **real-world performance.**
- **Psychosocial measures**, such as life space mobility, were largely **overlooked.**

KEY FINDINGS

- Smart wearables offer **continuous monitoring** in home and clinical settings.
- Commercially available smartwatches showed **positive applications**, but performance remains **device-, condition-, and parameter-specific.**
- **Standardizing** wearable **placement** on the body remains a major **challenge.**
- **Future research** should prioritize monitoring **psychosocial parameters** and expanding wearable use in **real-world settings** to better capture patient function and well-being.

BACKGROUND

- **Stroke recovery** is **monitored** using **standardized** clinical **tools** in controlled environments.
- These assessments are **time-limited** and **lack sensitivity to day-to-day fluctuations**.
- **Smart wearables** offer continuous**, real-world data beyond the clinic**.
- This study builds on the preceding scoping review and **explores the 24/7 use of wearables to track life metrics in stroke survivors** that may influence rehabilitation and recovery.

METHODS

- **Design:** Mixed-method, 3-year longitudinal study on upper limb recovery using **deep phenotyping** (motor, sensory, cognitive, psychosocial, and QoL assessments). The wearable component adds a **continuous monitoring layer**.
- **Sample: Stroke survivors** between 6–12 months post-stroke onset. (N = 5, ongoing).
- **Device:** Fitbit Inspire 3, worn **24/7 for 6 months**.

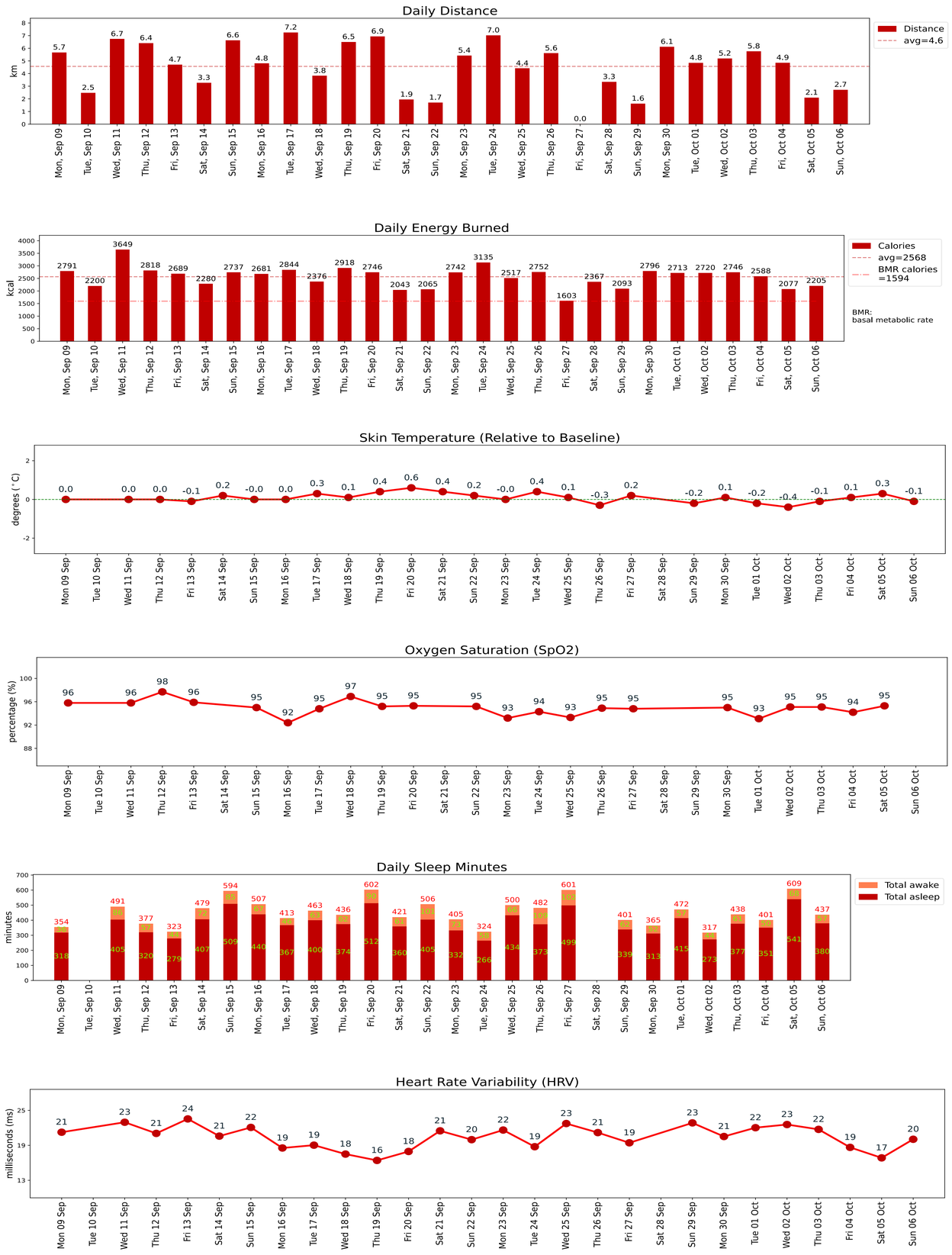


Figure 2. Example data from a stroke patient wearing a Fitbit Inspire 3. Selected variables from a specific month are displayed.

KEY FINDINGS

- Wearables offer a new window into **patient metrics beyond the clinical environment**.
- They capture day-to-day **fluctuations**, offering a more realistic view of the recovery process.
- **Proper** and **consistent use** remains a major **barrier** to data quality.
- Trust in the **reliability** and **validity** of wearable-derived metrics is still a **concern**.
- A key challenge is **integrating wearable data into rehabilitation sessions** and moving beyond exploratory research toward hypothesis-driven applications.

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