



Health-Related Activity and Sleep Behaviours in SuperAgers: Preliminary Observational Findings from Daily Activity Monitoring

Angela C. Roberts, PhD, MA-SLP^{1,2}, Karen Van Ooteghem, PhD³, Ivan Culum, PhD^{4,2}, Kit Beyer, PhD³, William Mcllroy, PhD³, Andrew Lim, MD^{5,6}, Ana Werneck Capuano, PhD⁷, Richard H. Swartz, MD, PhD^{5,6}, Oklikah Desmond, MA⁴, Emily Narayan, MSc⁴, Elizabeth Finger, MD⁸, Ozioma Okonkwo, PhD⁹, Robert Barthä, PhD⁸, Felicia Goldstein, PhD¹⁰, Adam Martersteck, PhD¹¹, Amanda Cook Maher, PhD¹², Rhiana Schafer, BA¹¹, Emily Rogalski, PhD¹³, and the SuperAging Research Initiative. ¹Communication Sciences and Disorders & Computer Science (Joint), Western University, London, ON, Canada, ²Canadian Centre for Activity and Aging, Western University, London, ON, Canada, ³Kinesiology, University of Waterloo, Waterloo, ON, Canada, ⁴Faculty of Health Sciences, Western University, London, ON, Canada, ⁵Clinical Neurology, Sunnybrook Health Sciences, Toronto, ON, Canada, ⁶Medicine, University of Toronto, Toronto, ON, Canada, ⁷Neurology, The University of Chicago, Chicago, IL, USA, ⁸Schulich School of Medicine and Dentistry, Western University, London, ON, Canada, ⁹Geriatrics and Gerontology, University of Wisconsin, Madison, WI, USA, ¹⁰Department of Medicine, Emory University, Atlanta, GA, USA, ¹¹Department of Neurology, University of Chicago, Chicago, IL, USA, ¹²Psychiatry, University of Michigan, Ann Arbor, MI, USA, ¹³The University of Chicago, Chicago, IL, USA.

INTRODUCTION

- The SuperAging Research Initiative examines adults aged 80+ with episodic memory comparable to those in their 50s–60s.
- SuperAgers** represent an exceptional phenotype that resists typical age-related cognitive decline.
- Three behavioural constructs are central to understanding cognitive resilience: **sleep-wake regulation** (linked to circadian disruption and cognitive decline), **physical activity patterns** (volume and consistency), and **day-to-day behavioural variability**. This is the **first study** to apply continuous remote wearable monitoring to characterize free-living behaviour in prospectively enrolled, rigorously defined SuperAgers. Study objectives: (1) establish protocol feasibility in adults aged 80+, and (2) characterize daily sleep, activity, and sedentary behaviour in SuperAgers vs. cognitively average controls.

OBJECTIVES

- Establish protocol feasibility in adults aged 80+ with exceptional (SuperAgers) or age-typical (Control) memory abilities.
- Characterize daily sleep, activity, and sedentary behaviour in SuperAgers vs. cognitively average controls.

METHODS

- Cross-sectional, observational design** embedded within the multisite SuperAging Research Initiative. Data collected from October 2022 to June 2025 at five North American sites (Chicago, IL; Atlanta, GA; Madison, WI; Ann Arbor, MI; London, ON).
- Remote wearable protocol:**
 - Research-grade sensors were mailed to participants' homes from a central coordination site.
 - Sensors are mailed in a ready-to-use state. No charging or user setup required.
 - Wrist- and ankle-worn inertial measurement units (Axivity AX6) worn continuously for 10–12 days; chest-worn ECG device (Bittium Faros 360) worn with scheduled rest breaks.
 - Short remote check-ins every 3-4 days facilitate compliance and safety monitoring.
 - Final discharge visit to assist with packing devices. Devices are returned via courier for centralized data offloading and processing.
- Wearable-derived outcomes** included daily step count and mobility (ankle gyroscope), sedentary time and moderate-to-vigorous physical activity (MVPA; wrist accelerometer, validated cut-points), and sleep duration and efficiency (wrist accelerometer, validated algorithms). Only participants with ≥4 valid wear days (≥20 hrs/day) were included in group comparisons (n=98–99).
- Day-to-day variability** was quantified as the coefficient of variation (CV = SD/mean × 100%) across valid wear days. Both median daily values (volume) and CV (regularity) were examined for each outcome, generating 10 primary comparisons.
- Multivariable linear regression** compared SuperAgers vs. Controls on each outcome, adjusting for age and sex. Open-source purpose-built analytics pipeline: github.com/nimbal/nimbalwear (Beyer et al., 2024).

RESULTS AND KEY FINDINGS

Table 1. Participant Demographics

	ALL (n=100)	SUPERAGER (n=49)	CONTROL (n=51)
Median Age, yr (IQR)	84.0 (81–88)	83.0 (81–86)	85.0 (82–89)
Female sex, n (%)	65 (65.0%)	40 (81.6%)	25 (49.0%)
White race, n (%)	88 (88.0%)	41 (83.7%)	47 (92.2%)
Education, mean yrs (SD)	16.9 (2.5)	17.1 (2.5)	16.7 (2.5)
Lives alone, n (%)	47 (47.5%)	24 (49.0%)	23 (46.0%)
Independent ADLs, n (%)	97 (98.0%)	49 (100%)	48 (96.0%)
Rey Auditory Verbal Learning Task Delayed Recall, mean (SD)	7.9 (3.0)	10.5 (1.9)	5.4 (1.3)
Trail Making Test (Part B), mean sec (SD)	114.3 (134.7)	106.0 (135.5)	122.2 (134.8)
Category Fluency (Animals), mean (SD)	20.5 (4.7)	21.6 (5.4)	19.4 (3.7)
Multilingual Naming Test, mean (SD)	30.4 (2.0)	30.3 (2.3)	30.6 (1.7)

Table 3. SuperAger vs. Control: Median daily values and day-to-day variability (CV) adjusted for age and sex

	MOBILITY		ACTIVITY LEVEL				SLEEP			
	Stepping (steps/day)		Sedentary Time (min/day)		MVPA Time (min/day)		Duration (min/day)		Efficiency (%)	
	Median	CV (%)	Median	CV (%)	Median	CV (%)	Median	CV (%)	Median	CV (%)
SuperAger (n=48)	9622.7	25.9	703.9	10.5	41.8	43.6	400.5	15.8	84.3	6.2
Control (n=50)	8646.4	25.0	688.3	11.3	28.8	43.3	413.6	16.0	80.2	8.7
Adj. mean diff.	594.2	1.5	27.7	-1.3	27.4%	12.3%	-11.6	-1.5	2.9	-20.9%
p-value	.507	.508	.211	.266	.215	.277	.405	.362	.104	.041

Table 2. Sensor Data Collection Volume and Wear Compliance (Median, IQR)

	Ankle (n=100)	Wrist (n=100)	Chest (n=85)*
Collected days	8.0 8.0-9.0	9.0 8.0-9.0	9.0 8.0-9.0
Wear days	8.0 6.0-9.0	8.0 6.0-9.0	6.0 5.0-7.0
Break days	0.0 0.0-2.0	0.0 0.0-2.0	2.0 2.0-3.0
Data completeness	90.0% 88.9%-100.0%	100.0% 88.9%-100.0%	100.0% 88.9%-100%
Wear adherence	100.0% 100.0%-100.0%	100.0% 100.0%-100.0%	100.0% 100%-100%

Note. The evidence-informed optimal threshold for 24-hour sensor wear periods is four 24-hour days. *Excludes participants without available ECG data.

KEY FINDING 1 Protocol Feasibility: Remote, multi-sensor wearable monitoring is **feasible and acceptable** in adults aged 80+. 97% completed the protocol independently; 93.7% of devices captured ≥4 wear days; median daily wear adherence was 100% (**Table 2**). Adverse events (n=11) were minor, mostly mild skin irritation from the ECG adhesive patch.

KEY FINDING 2 Sleep Regularity: SuperAgers showed **significantly lower night-to-night variability in sleep efficiency** (CV: 6.2% vs. 8.7%; adjusted difference: −20.9%, 95% CI: −36.9% to −1.0%; **p=0.041**), indicating more consistent sleep quality across nights (**Table 3**).

KEY FINDING 3 Activity & Sleep Volume: SuperAgers and Controls showed **broadly similar activity profiles**. Point estimates favoured SuperAgers but did not reach significance for daily steps, MVPA, and median sleep efficiency. (**Table 3**).