Using Functional Measures and AI to Predict Resilient Outcomes

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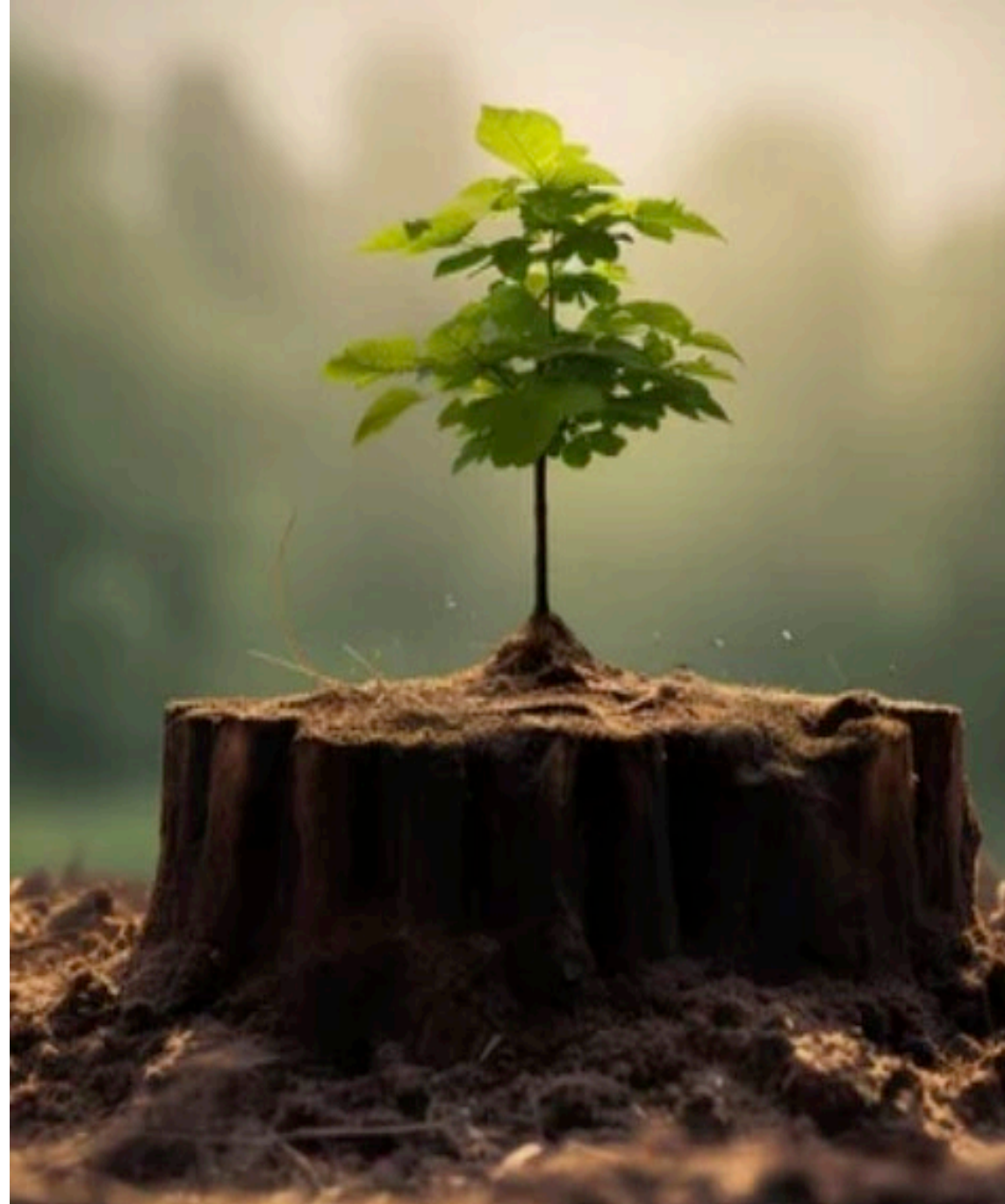
Physical Function & Physical Resiliency

- Resilient physical function
  - Meet or exceed pre-stressor levels
  - Absence of decline
- Trajectories of function
  - Loss, gain, recovery
- Ability to perform favorite activities
  - Quality of life

Measures of Physical Function

- Self-report of difficulty or dependency in daily activities
  - Mobility
  - Physical function
  - ADLs, IADLs
- Performance Measures
  - SPPB
    - Gait Speed
    - Chair Stands
    - Standing Balance
  - Grip Strength
  - Endurance Walking
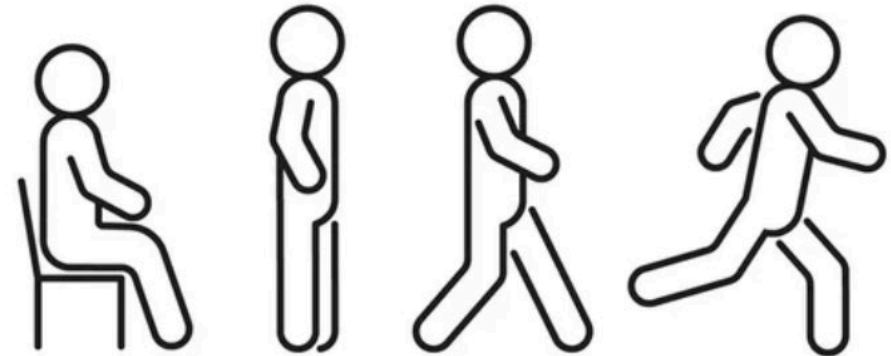
LOWER-EXTREMITY FUNCTION IN PERSONS OVER THE AGE OF 70 YEARS AS A PREDICTOR OF SUBSEQUENT DISABILITY

Jack M. Guralnik, M.D., Ph.D., Luigi Ferrucci, M.D., Ph.D., Eleanor M. Simonsick, Ph.D., Marcel E. Salive, M.D., M.P.H., and Robert B. Wallace, M.D.
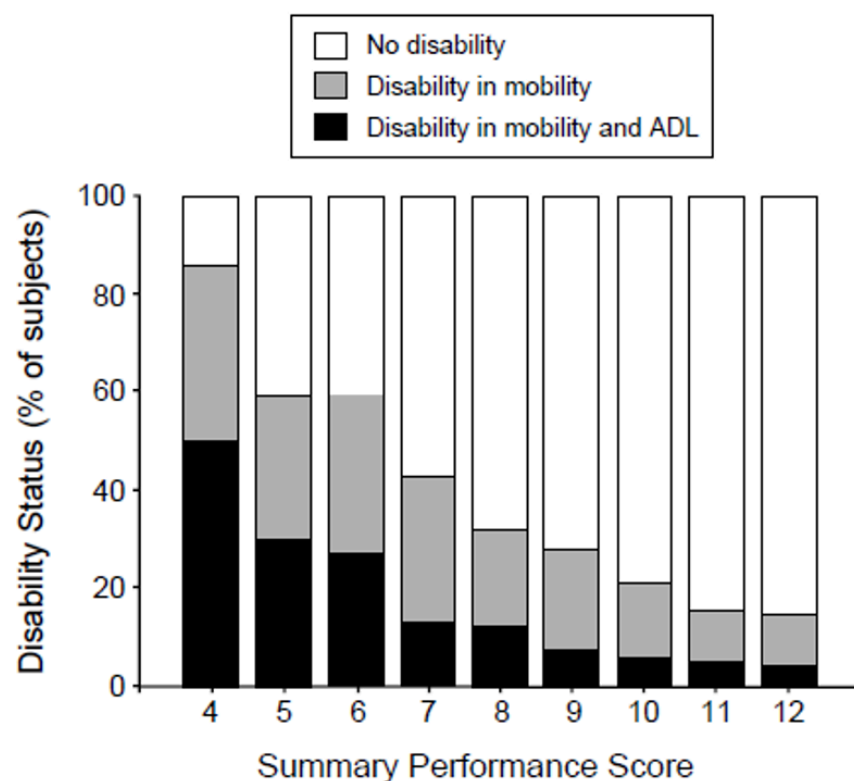

Table 2. Adjusted Relative Risk of Disability at Four Years of Follow-up, According to the Summary Performance Score at Base Line.*

Summary Performance Score	No. of Subjects†	Disability in ADL		Mobility-Related Disability	
		No. with Disability	RR (95% CI)	No. with Disability‡	RR (95% CI)
4–6	112	32	4.2 (2.3–7.7)	70	4.9 (3.1–7.8)
7–9	487	50	1.6 (1.0–2.6)	159	1.8 (1.3–2.5)
10–12	522	29	1.0	94	1.0

Physical function in the context of physical resiliency:

Individual improvement vs. population level trends

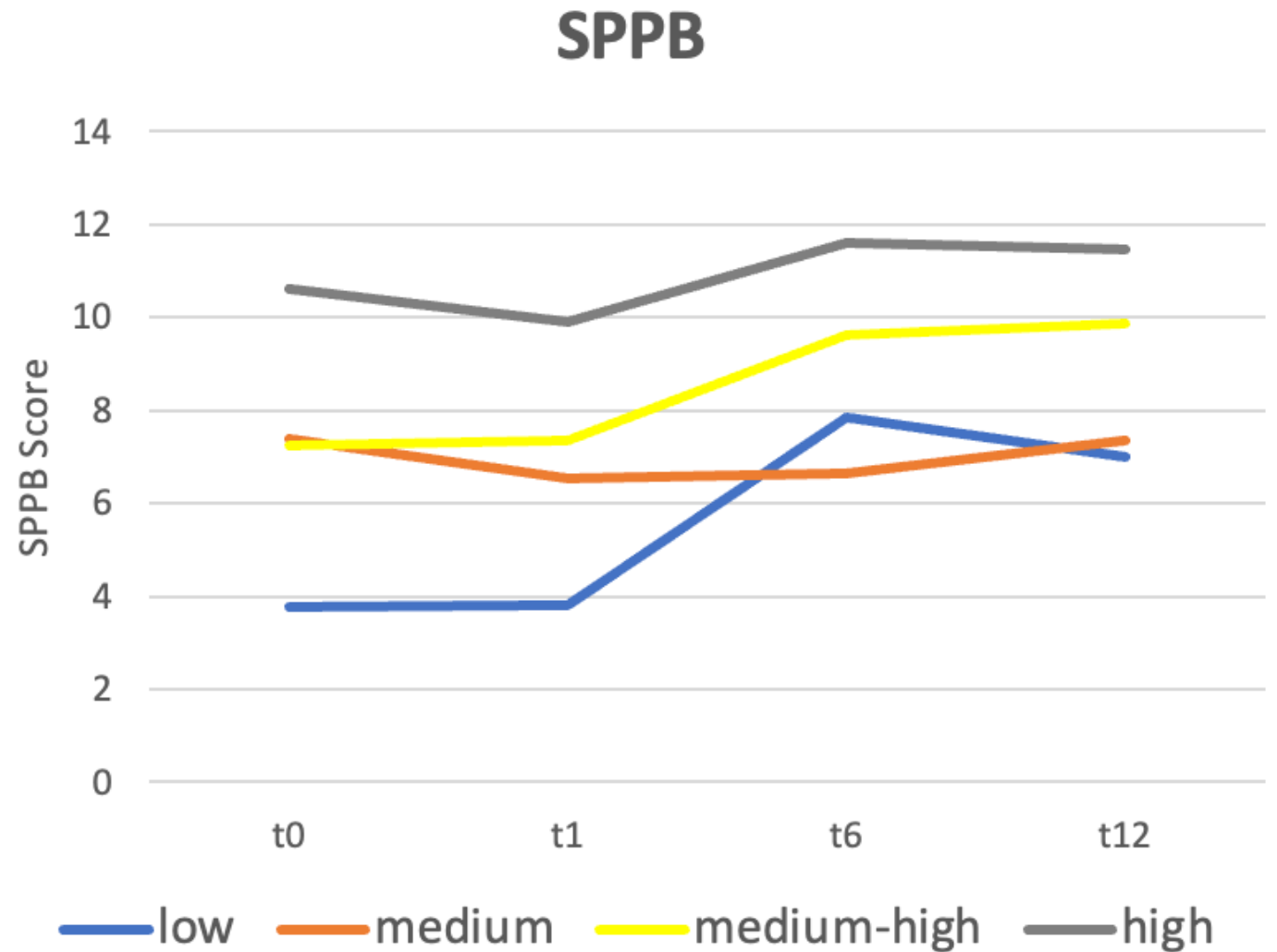## Does low function mean low resilience?

Figure courtesy of Qian-Li Xue

Fatigability & Physical Resiliency

- Perception of fatigue in relation to a standardized task

- Standardizes fatigue in the research and clinical settings

- Commonly assessed using:
  - Pittsburgh Fatigability Scale
  - Standardized Treadmill Walk (e.g., 5 min at 1.5 mph/0.67 m/s)
  - Endurance walking task

- Associated with: physical function, inflammation, body composition, cognition, CVD, cancer, energy utilization

Fatigability & Physical Resiliency

- Meaningful to understanding endurance capacity, physical function, and quality of life

- Combines physical task with perception of difficulty

- Quantitative and qualitative aspects

Pittsburgh Fatigability Scale

	Physical Fatigue No Fatigue → Extreme Fatigue 0 ←———→ 5
a. Leisurely walk for 30 minutes	0 1 2 3 4 5
b. Brisk or fast walk for 1 hour	0 1 2 3 4 5
c. Light household activity for 1 hour *(cleaning, cooking, dusting, straightening up, baking, making beds, dishwashing, watering plants)*	0 1 2 3 4 5

Rating	Descriptor
6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very Hard
18	
19	Extremely hard

Fatigability & Physical Resiliency

Tracking fatigability over time as a measure of physical resiliency
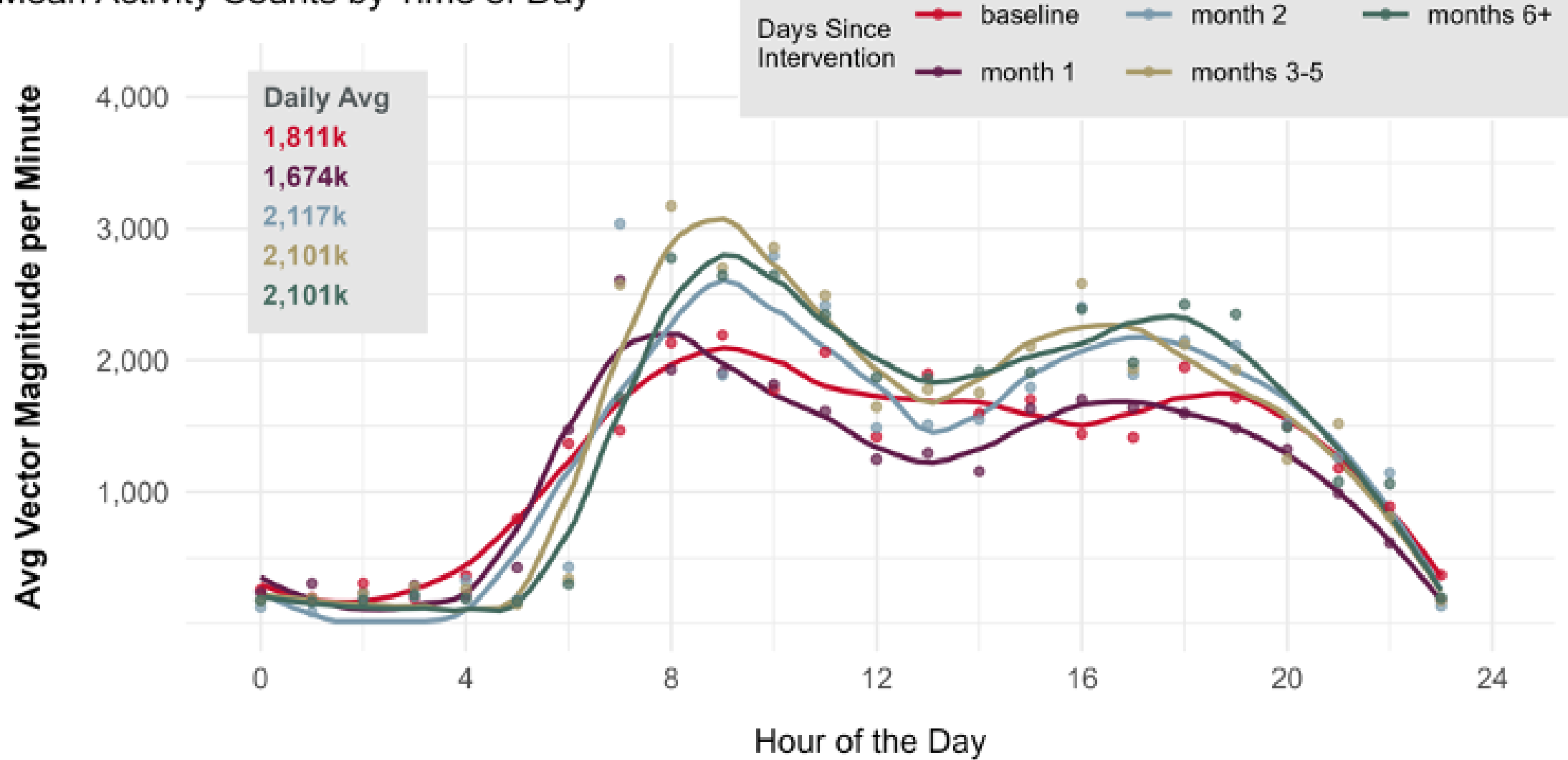

Marino F, et al, MSSE 2024
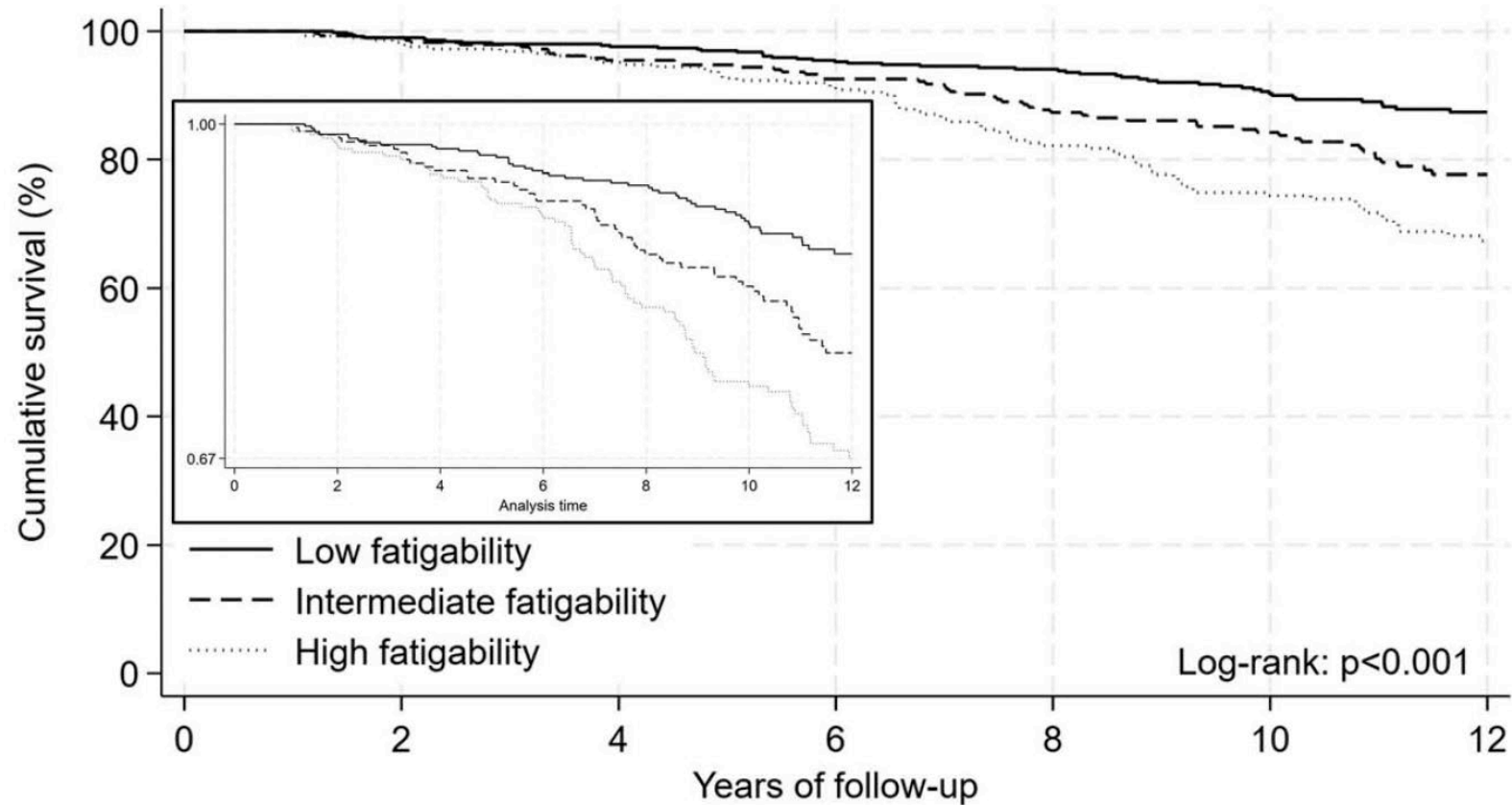
Artificial Intelligence & Physical Resiliency

- AI and digital technologies hold promise for improved monitoring and understanding of patient health
  - Wearable devices, voice assistants, robotics
  - Machine learning, computer vision, natural language processing
- Clinical measures and free-living measures
  - Gait technology (gait mats, motion capture systems)
  - In-home activities, medication adherence
- Dynamic/time-series ambulatory measures
  - Movement, sleep, heart rate & arrhythmias, continuous glucose, blood pressure, SpO_2, skin temperature

Mean Activity Counts by Time of Day

Days Since Intervention: baseline, month 2, months 6+, month 1, months 3-5

Daily Avg
1,811k
1,674k
2,117k
2,101k
2,101k

Avg Vector Magnitude per Minute

Hour of the Day

Unpublished data

Summary & Considerations

- Physical function (traditional) and AI (novel) provide important insights into <u>physical resiliency</u>

- Need to Consider
  - Interplay with cognitive & sensory function
  - Combining patient perception with objective measurement
  - Combining traditional (in-lab/clinic) and real-world measures
  - How to gauge relative vs. absolute change
    - Individual vs. Population level

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