



# Relationships between real-world behavior, performance, and perceived physical function in cancer survivors

Shelby Bachman, PhD  
Research Scientist  
VivoSense



# About VivoSense

VivoSense develops and validates real-world digital clinical measures and provides end-to-end services and solutions for their delivery in regulated clinical trials



## Technology

Compliant, human-augmented, AI-driven analytics software platform



## Clinical Operations

High-touch project & trial mgmt., vendor mgmt., site & patient training, near real-time compliance & alerting, timely & custom data transfers



## High-Quality Data

Ingest, clean, analyze, and interpret data from almost any wearable sensor, Context-specific Population and validation



## Expert Consulting

Inform trial design and fit-for-purpose solutions for regulatory submissions

# The importance of physical function in cancer survivorship

- Maintaining health-related quality of life (HRQoL) in cancer survivorship is a priority for patients, clinicians, regulators, and drug developers



- Physical function is one aspect of HRQoL that is heavily impacted by cancer and its treatments
- Established assessments of physical function in oncology clinical research include:



Patient-reported  
outcome  
assessments



Clinician-reported  
outcome  
assessments



Performance  
outcome  
assessments

# Established assessments of physical function are limited

Burdensome

Performed  
infrequently

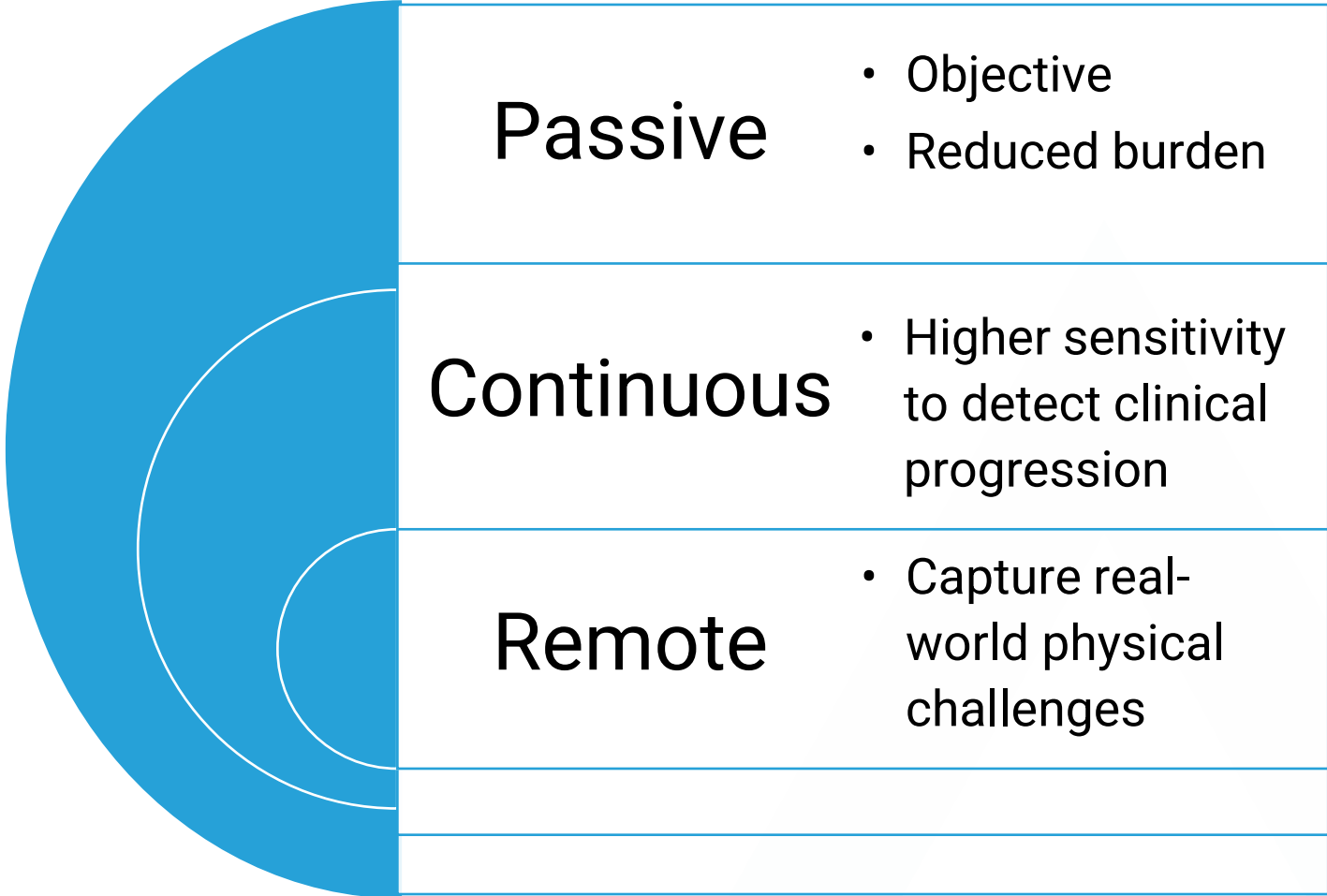
Prone to ceiling  
effects

Do not capture  
patients' real-world  
physical challenges

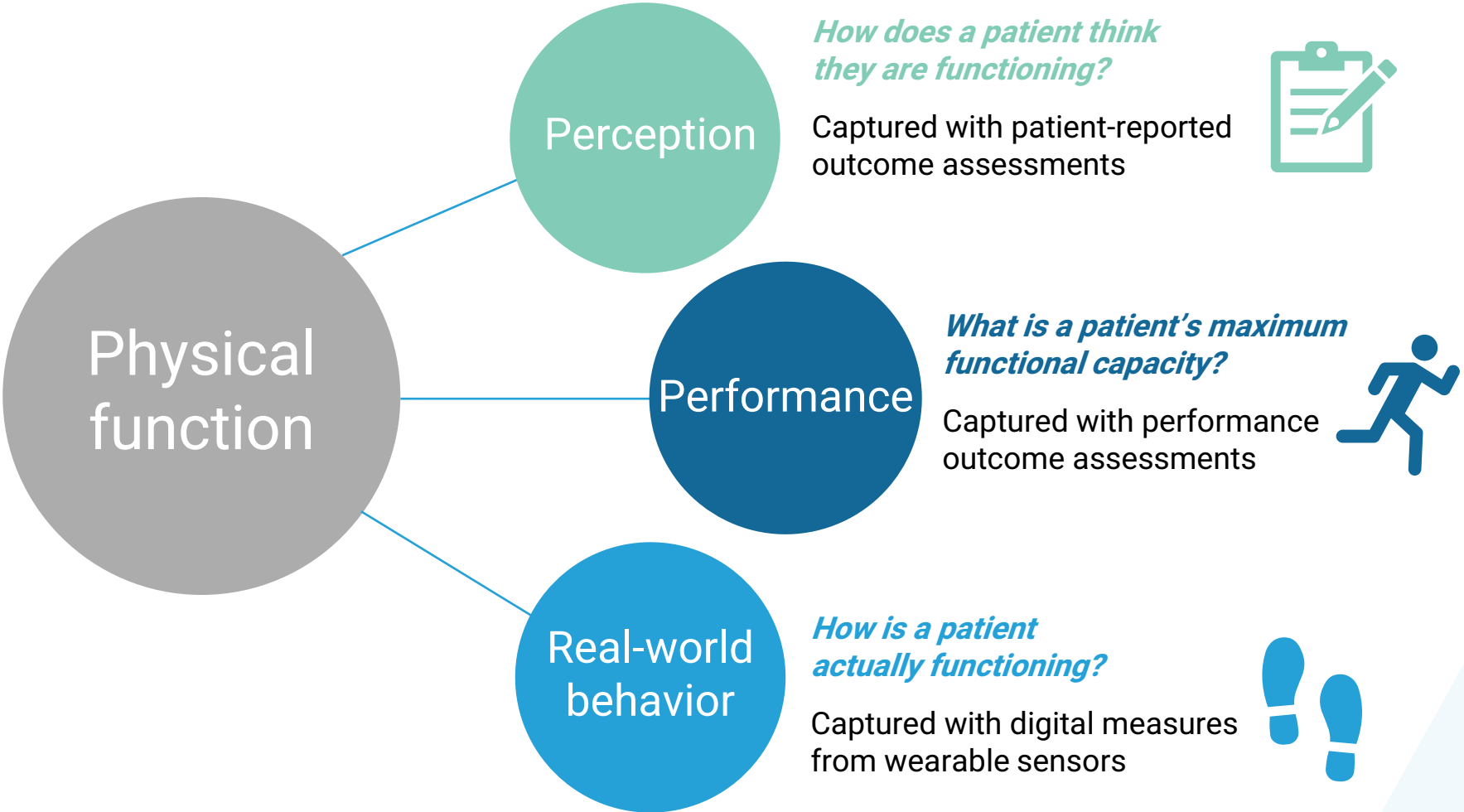
# Can wearable sensors improve the assessment of physical function in oncology?



Wearable sensors can capture **real-world physical behavior** and have the potential to address some of the limitations of established physical function assessments



# Toward holistic measurement of physical function in oncology



In cancer survivors, how is real-world physical behavior related to perceived physical function and performance?

# Participants were 86 cancer survivors who had completed treatment for breast, colon, or rectal cancer

Age range	21 - 85 years
% female	71%
BMI range	18 - 43
Average time since diagnosis	2.7 years
Average time since last treatment	1.8 years



COLORADO STATE UNIVERSITY

Dr. Heather Leach  
Emma Gomes



Grant #131629-MRSG-  
18-021-01-CPPB

# Multimodal assessments of physical function



**Perceived physical function** assessed with linked PROMIS Physical Function (PF) scores



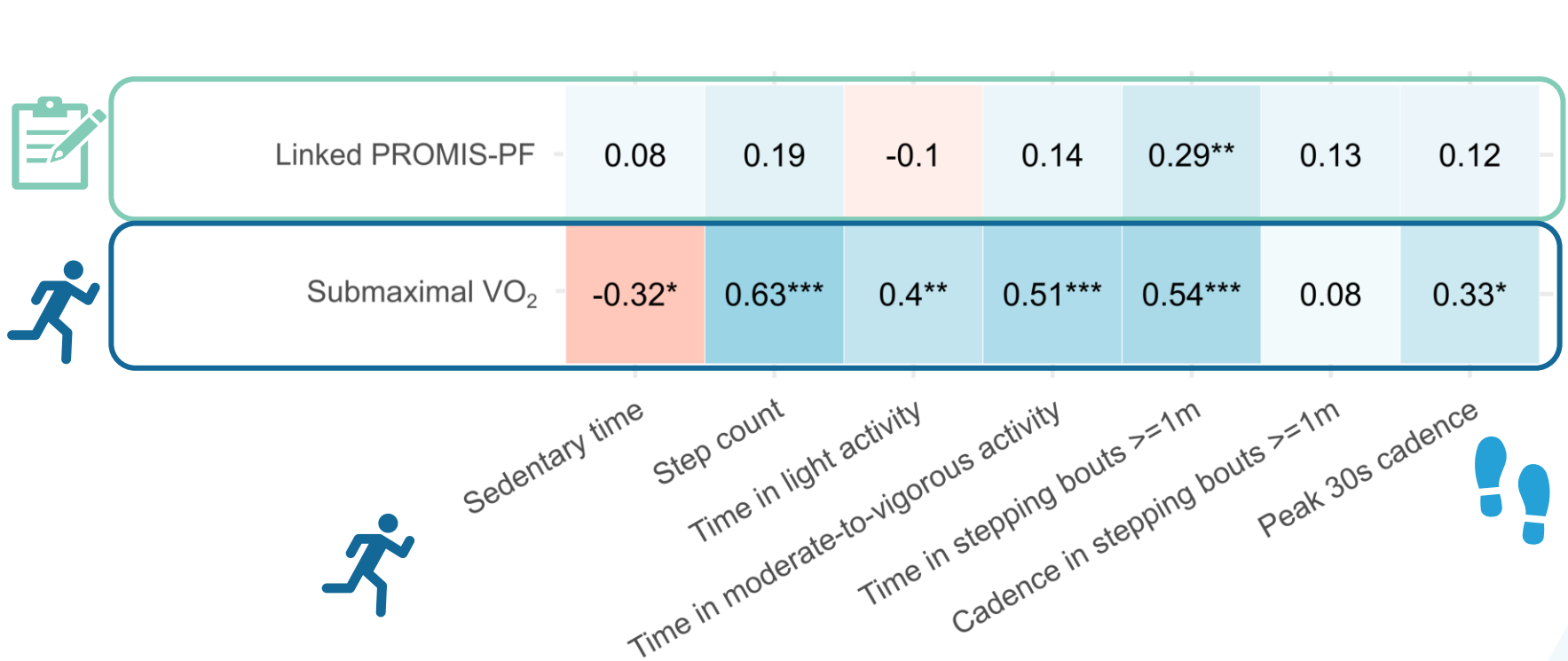
**Physical performance** calculated as  $VO_2$  during a submaximal exercise test



Thigh-worn accelerometer used to capture **real-world physical behavior** for 7 days



# Real-world behavior was related to performance, but not perceived physical function

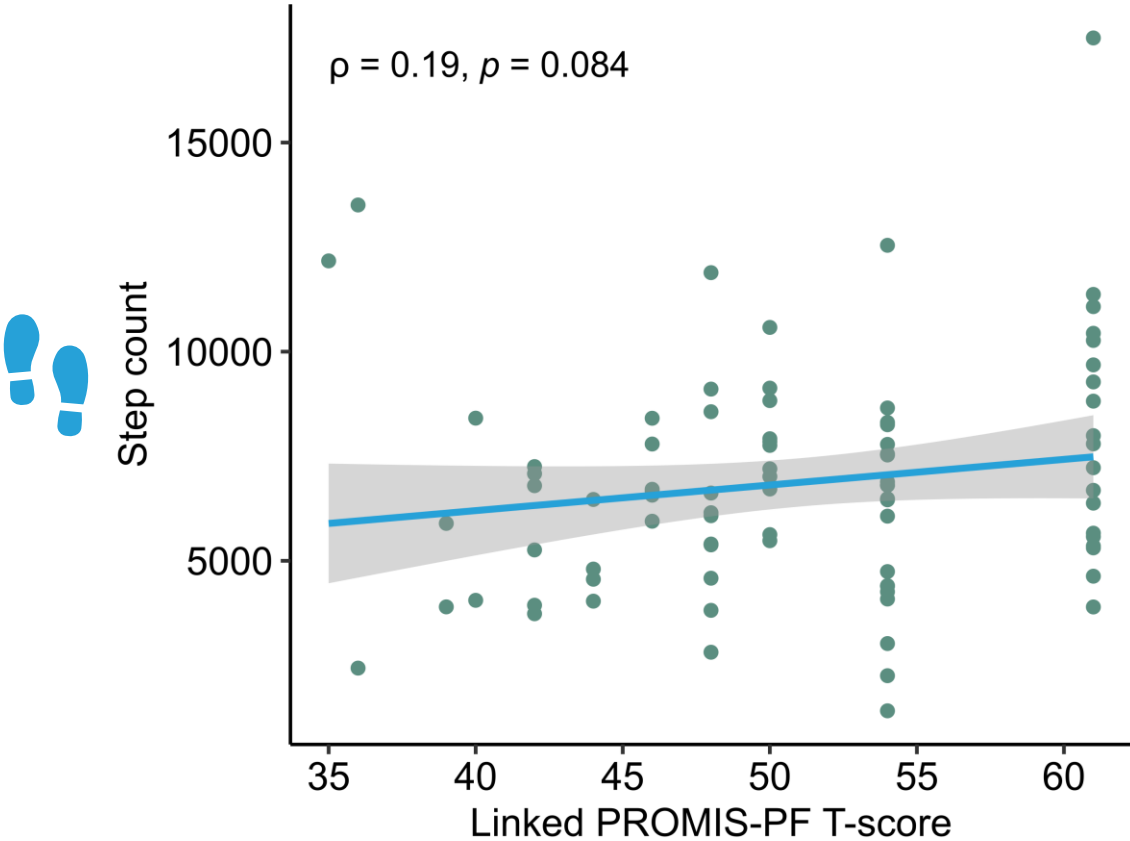


A Spearman correlation framework was used to test relationships with real-world physical behavior.

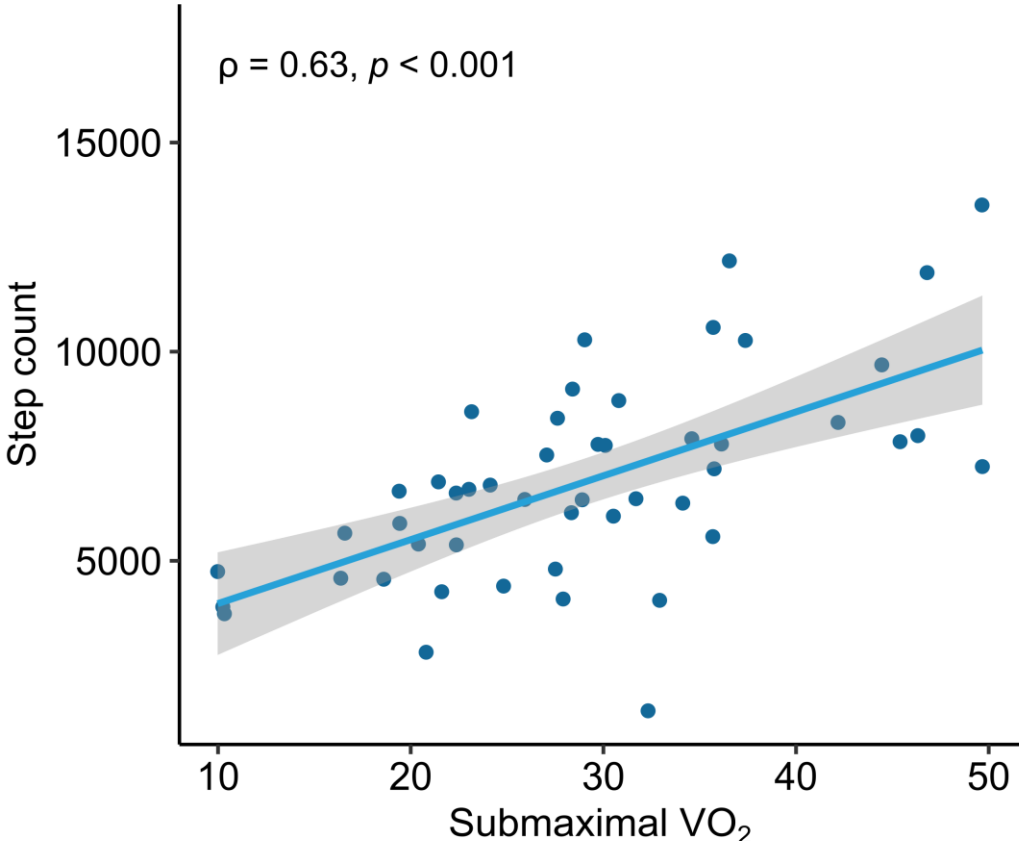
The pattern of significance was largely unchanged when accounting for effects of demographic and cancer characteristics in a partial correlation approach.

# Real-world behavior was related to performance, but not perceived physical function

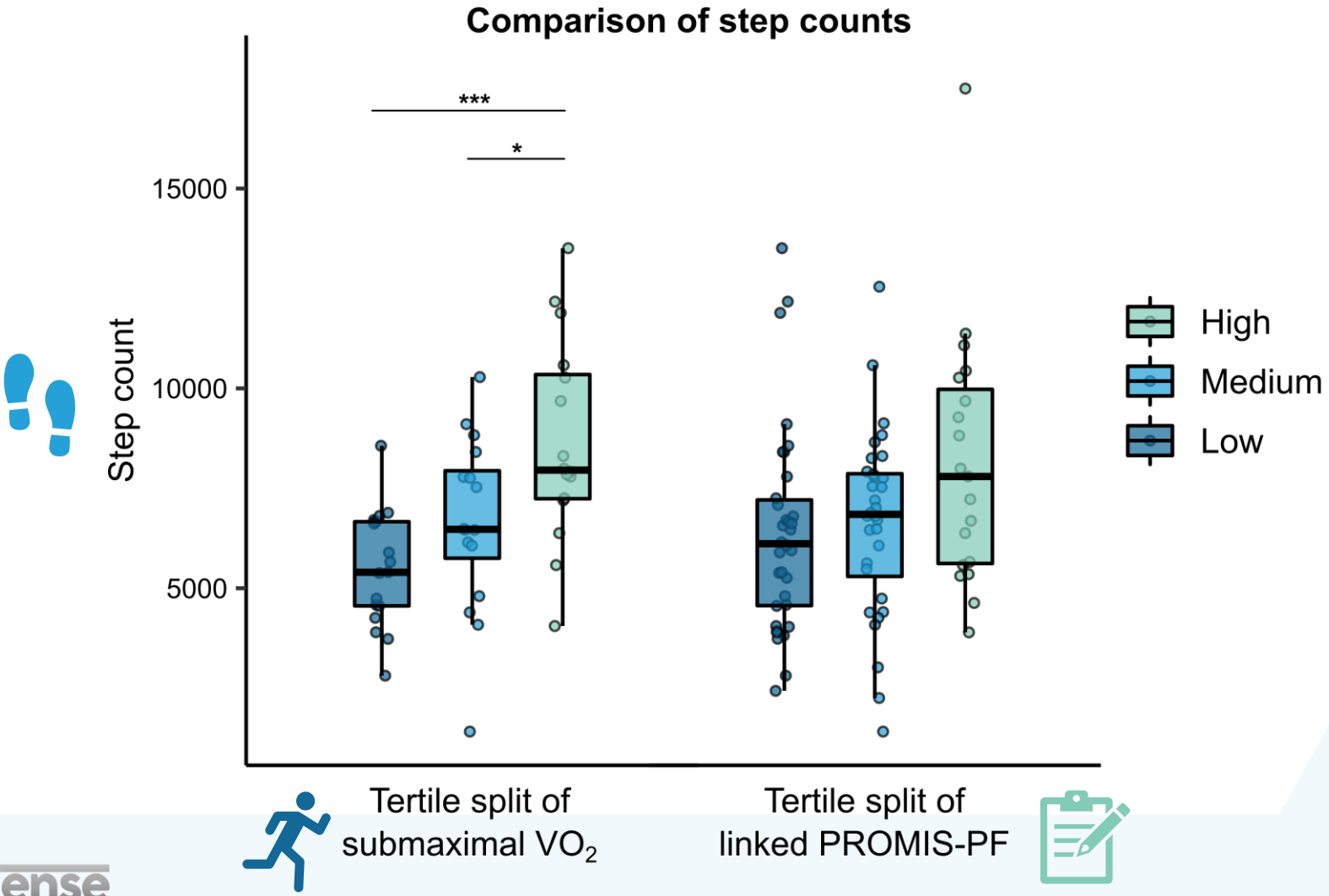
### Step count vs. PROMIS-PF



### Step count vs. submaximal VO<sub>2</sub>



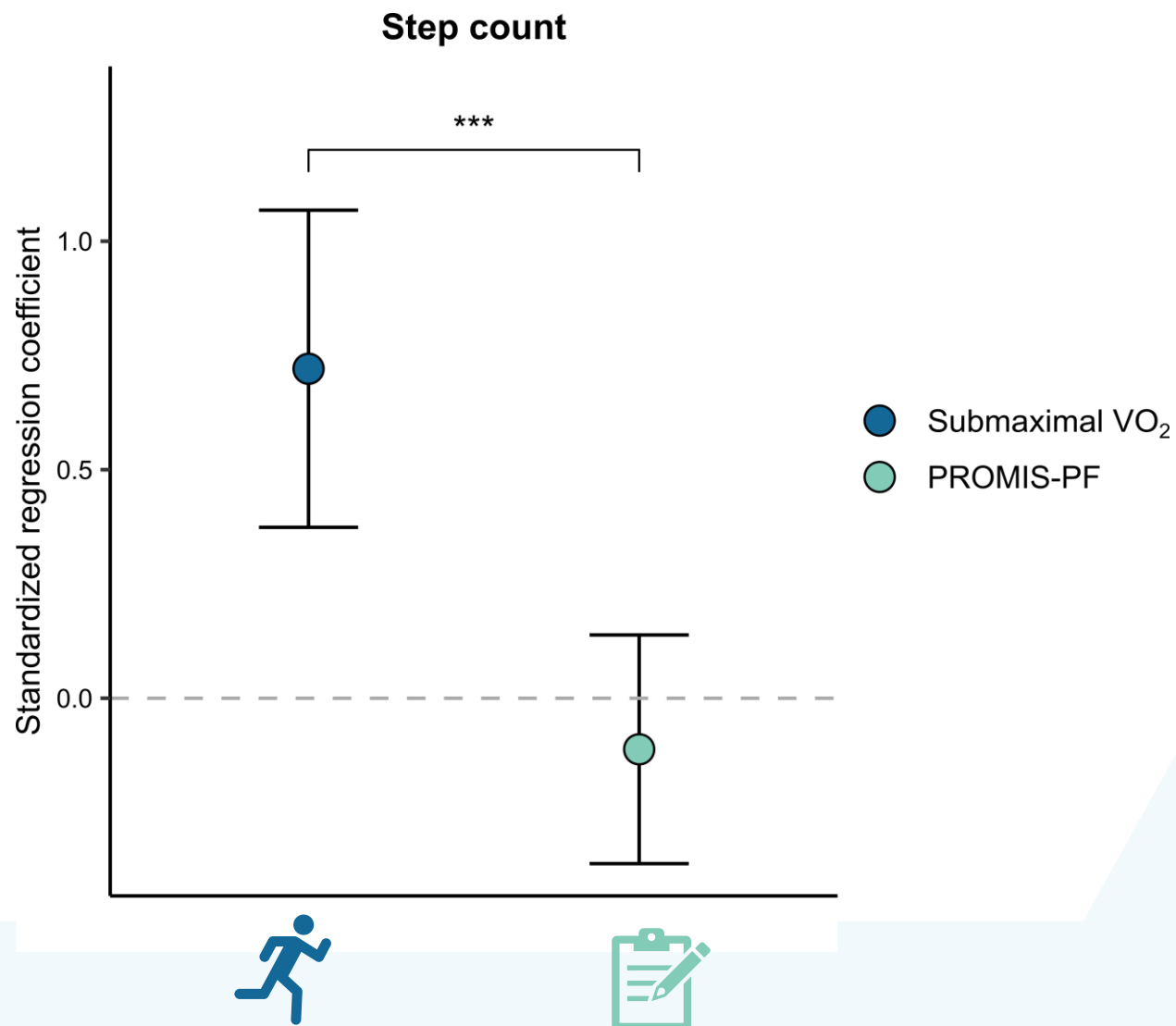
# Real-world behavior differed by performance, but not by perceived physical function



Mann-Whitney-U and Welch's *t*-tests used to compare splits in terms of the real-world behavior measures

- Individuals with higher vs. lower physical performance:
- took more steps
  - spent less time sedentary
  - spent more time in stepping bouts over 1 minute
  - spent more time in moderate-to-vigorous activity

# Real-world behavior was more related to performance than to perceived physical function



Likelihood ratio tests were used to compare fits of multiple linear regression models where coefficients were (1) unconstrained and (2) constrained to equality.

The following measures were more related to performance than to perceived physical function:

- Sedentary time
- Step count
- Time in light activity
- Time in moderate-to-vigorous activity
- Time in stepping bouts  $\geq$  1 minute

# Moving beyond the volume of physical behavior

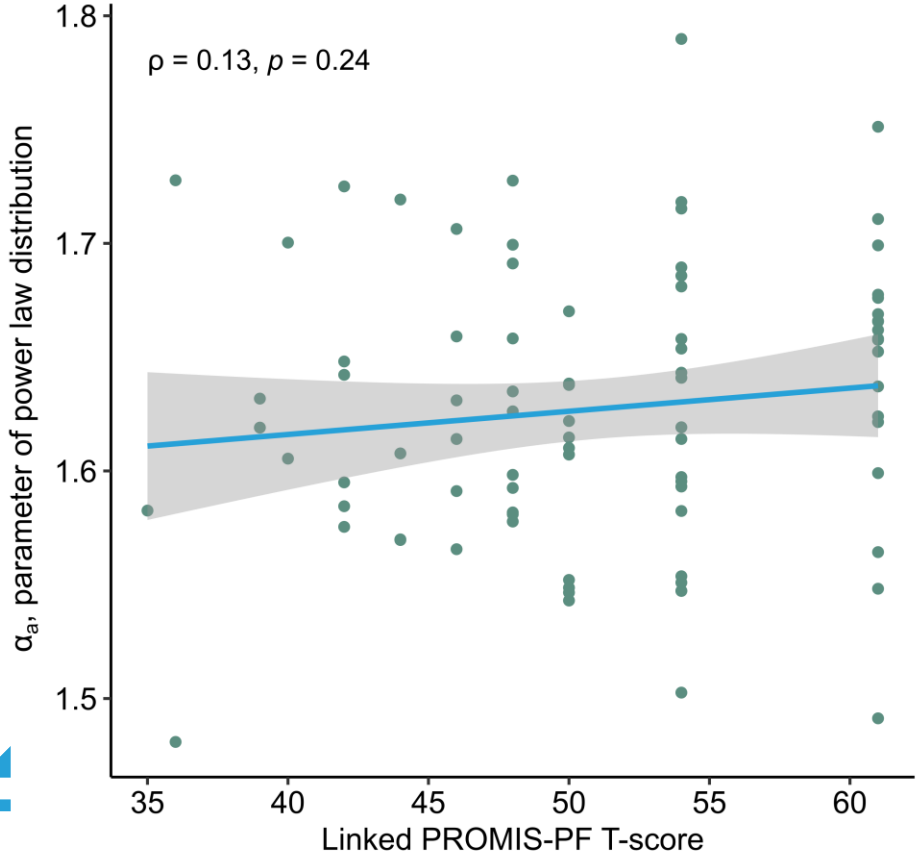
- Measures examined so far reflect the **volume** of real-world physical behavior
- We also examined measures of **activity fragmentation**, which reflects the pattern of activity accumulation



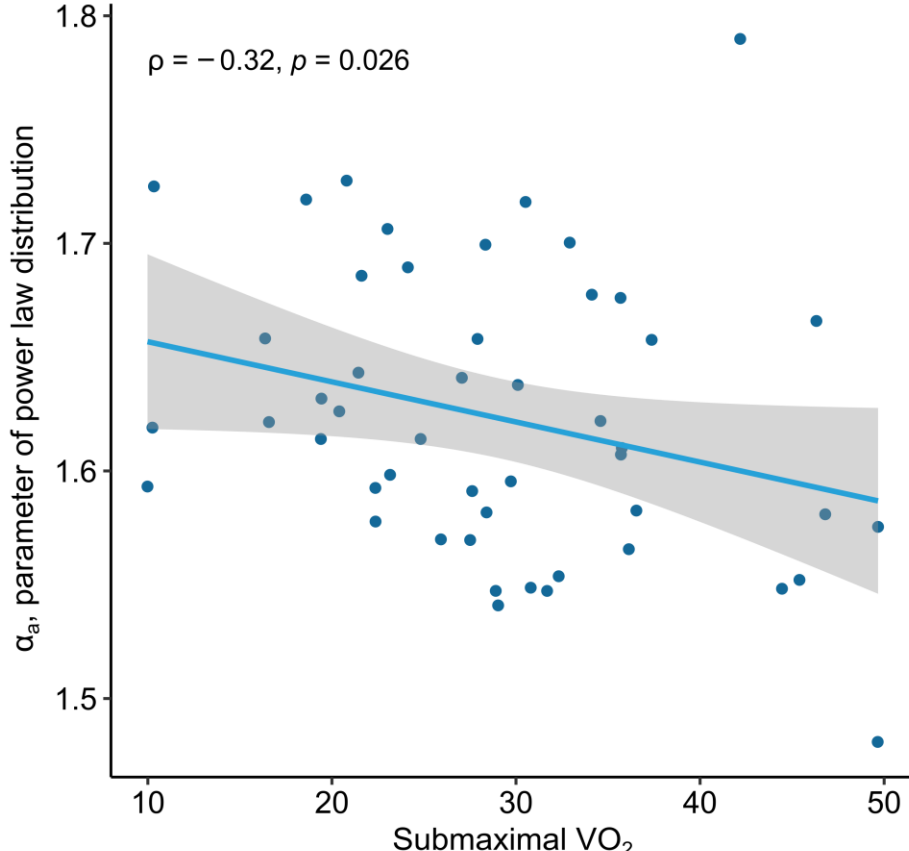
In cancer survivors, how is activity fragmentation related to perceived physical function and performance?

# Activity fragmentation was negatively correlated with performance but was not related to perceived physical function

$\alpha_a$  vs. PROMIS-PF



$\alpha_a$  vs. submaximal  $VO_2$



Individuals with lower physical performance had more fragmented activity, which was characterized by shorter, less frequent bouts of activity.



# Putting it all together



Digital measures of real-world physical behavior were more related to performance than perceived physical function



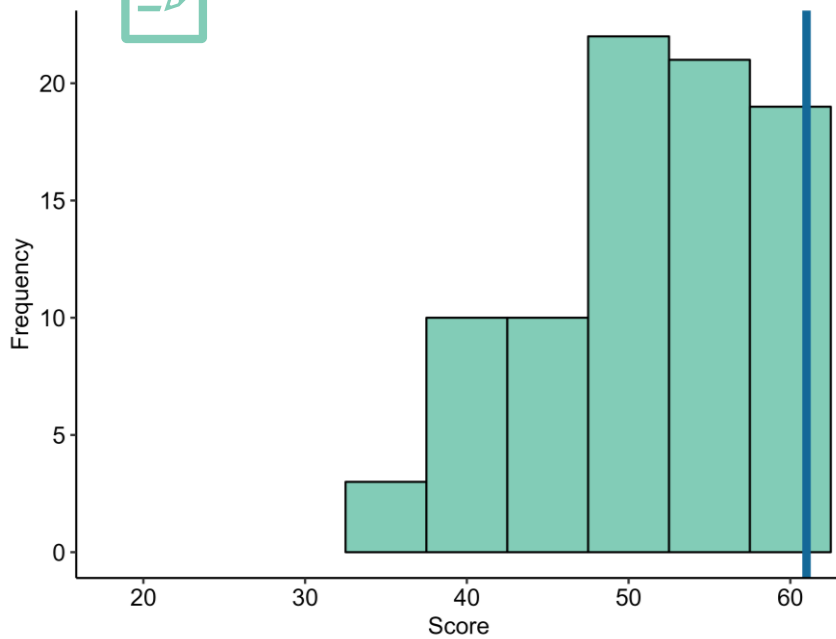
The fragmentation of activity was also associated with physical performance, but not perceived physical function

# Understanding the limited relationships between physical behavior and perceived physical function

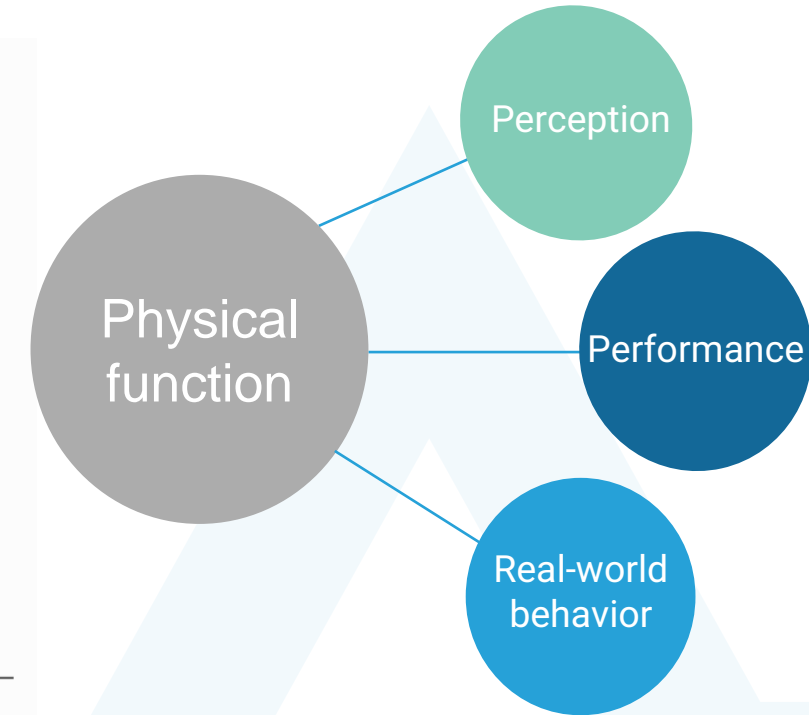
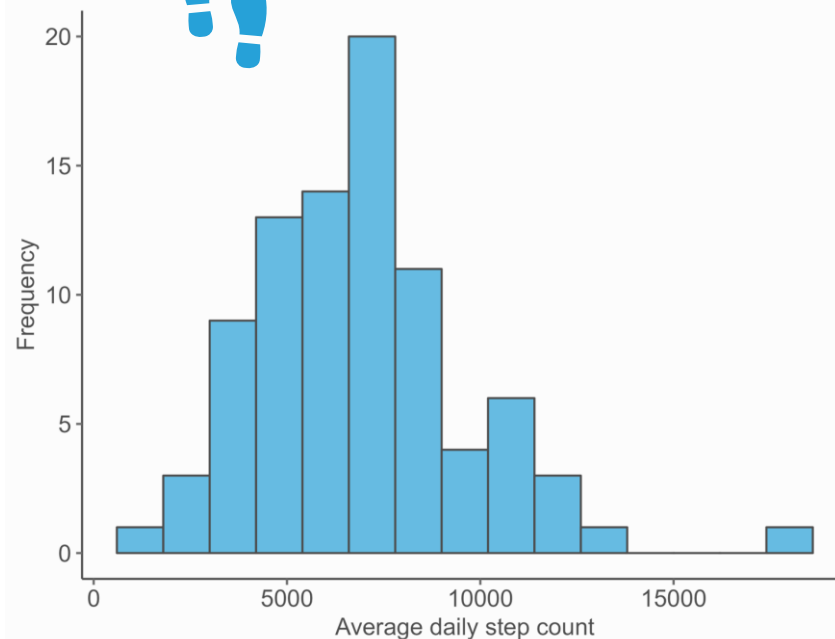
- Cross-sectional dataset
- Ceiling effects in perceived physical function
- Are patient-reported assessments unreliable?
- Are we measuring apples and oranges?



Linked PROMIS-PF T-scores  
(Possible scores range from 19-61)



Step count



Can digital measures **complement established measures** to more holistically capture physical function?



# What's next



## 12-week study in individuals undergoing anti-cancer treatment

- Test associations with real-world physical behavior over time
- Characterize feasibility and acceptability of remote monitoring
- Understand complementarity with established measures



## Identifying meaningful aspects of physical functioning for individuals living with cancer



## Goal of regulatory qualification



**Thank you!**

---