Assessment of Aging Related Changes in Postural Control Using Time to Contact

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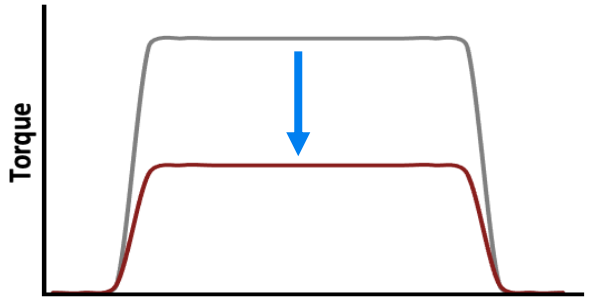
Fatigue and Fatigability

Muscle Fatigue

Decrease in maximal power with activity



may contribute to

has impact on

Performance Fatigability

Normalized metric of performance deterioration in response to a standardized activity

Postural Control

Maintenance of the body center of mass within the limits of stability

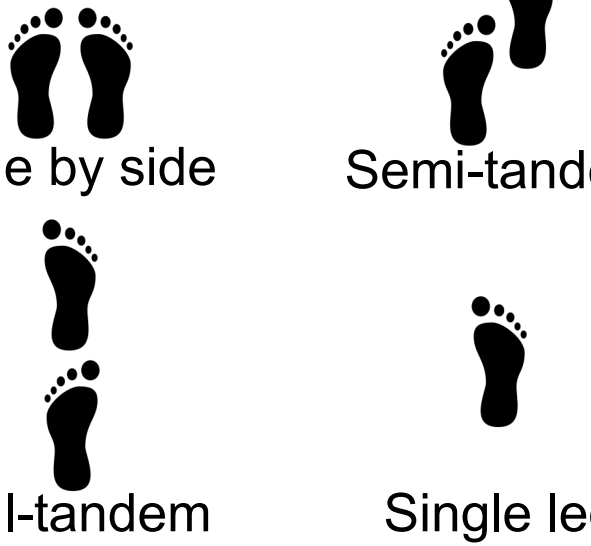
Enoka and Duchateau 2008, Shrack et al. 2020, Alexander 1994

Background – Postural Control

Current Clinical Assessment:

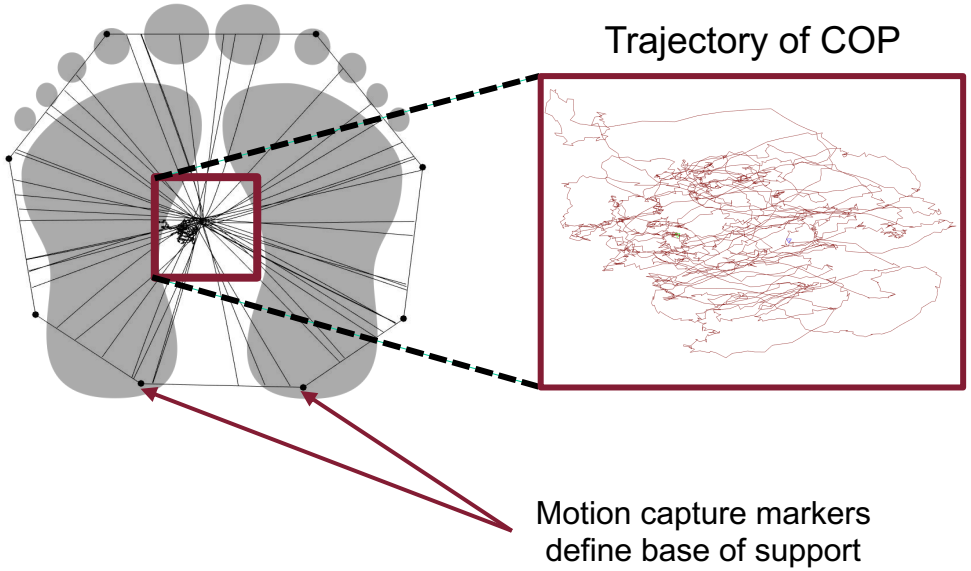
Advanced Standard Physical Performance Battery (SPPB-A)

4 stances held for a maximum of 30 seconds



Time-to-Contact (TTC):

Quantifies the time it would take for the center of pressure to contact a stability boundary



Simonsick et al. 2001, Slobounov et al. 1998, Tresilian 2012

Motivation & Purpose

Motivation:

- Time, the only measurement in the SPPB-A, does not provide data on **how** an individual is controlling their posture.
- **Aging** and **fatigue** are associated with declines in postural control.

Purpose:

Compare TTC in younger and older adults before and after a prolonged walk, previously shown to result in muscle fatigue

Data Collection

- 6 younger adults
  - 36.3 $\pm$ 3.27 years old
  - BMI: 23.2 $\pm$ 3.53 kg/m^2
- 9 older adults
  - 72.7 $\pm$ 2.18 years old
  - BMI: 25.5 $\pm$ 3.48 kg/m^2
- All participants were sedentary and free of previous musculoskeletal injury

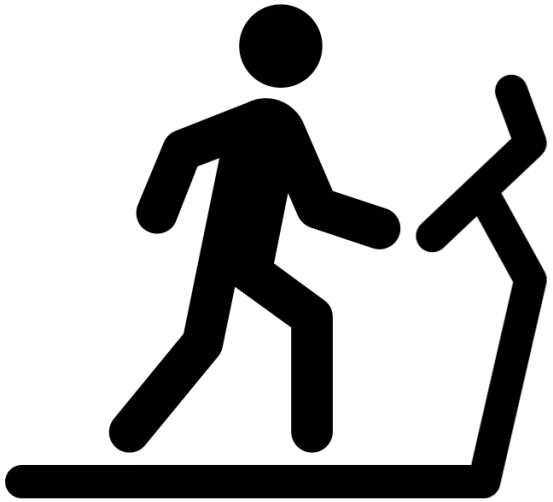
Data Collection

Four Balance Stances

On a force plate, hold for 30 seconds or until individual falls

Knee extensor isokinetic contraction

30 Minute Treadmill Walk (30 MTW)



Previously found to induce knee extensor muscle fatigue in younger and older adults

Four Balance Stances

On a force plate, hold for 30 seconds or until individual falls

Knee extensor isokinetic contraction

Foulis et al. 2017, Hafer et al. 2019

Data Processing

Step 1: Solve for τ_{min} which is assigned to the TTC

$$\frac{[a_y(t_i) - s \cdot a_x(t_i)]}{2}(\tau^2) + \frac{[v_y(t_i) - s \cdot v_x(t_i)]}{2}(\tau) + [(r_y(t_i) - y_h) - s \cdot (r_x(t_i) - x_h)] = 0$$

COP Acceleration | COP Velocity | COP Position | Boundary Slope

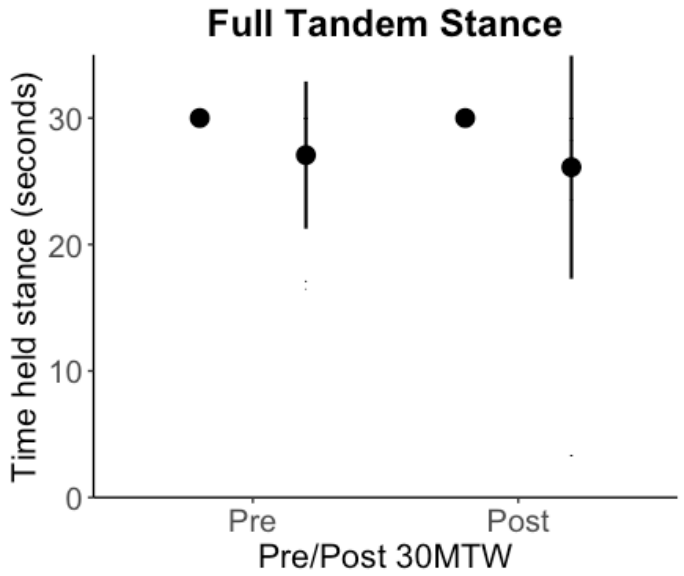
Step 2: Statistics

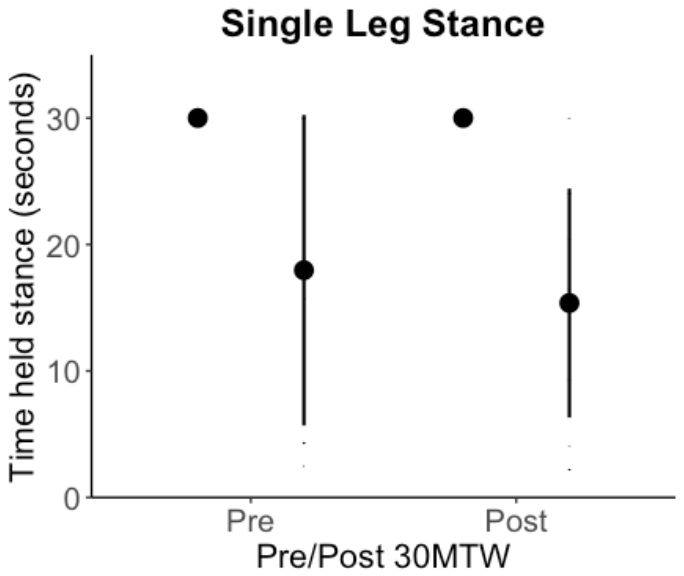
2x2 ANOVA with **Age** and **Time (pre/post 30MTW)** as factors

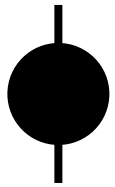
Slobounov et al. 1998, Haddad et al. 2006

Results

All participants held side by side and semi-tandem stances for the full 30 seconds





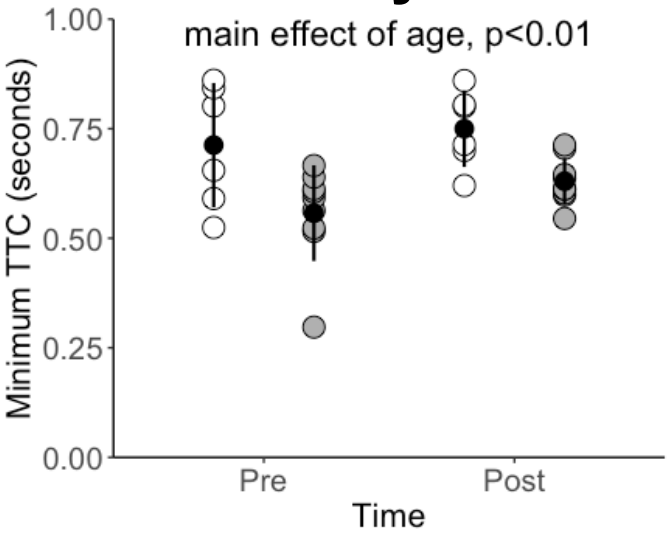


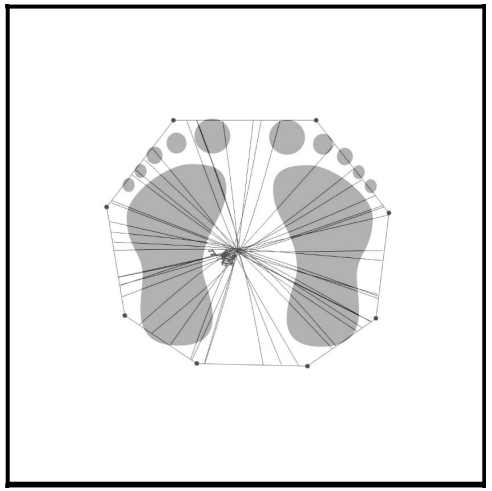
Mean ± SD

No significant differences in peak knee extensor torque from before to after the 30MTW

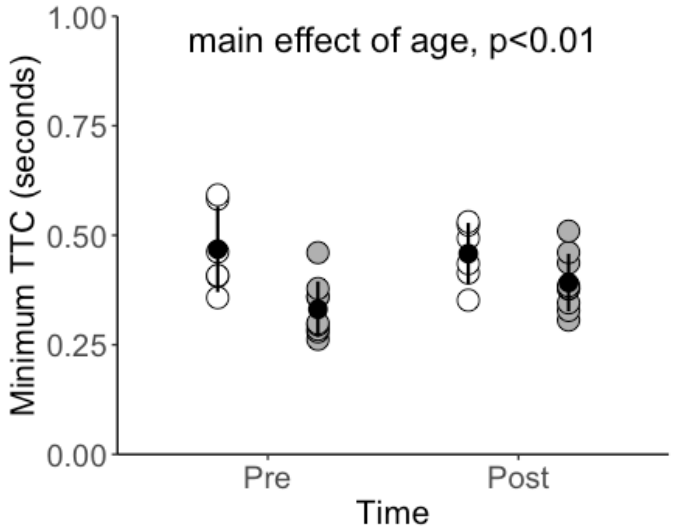
Results

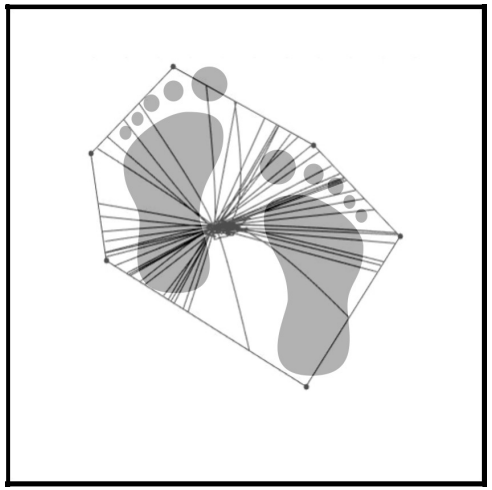
Side by side



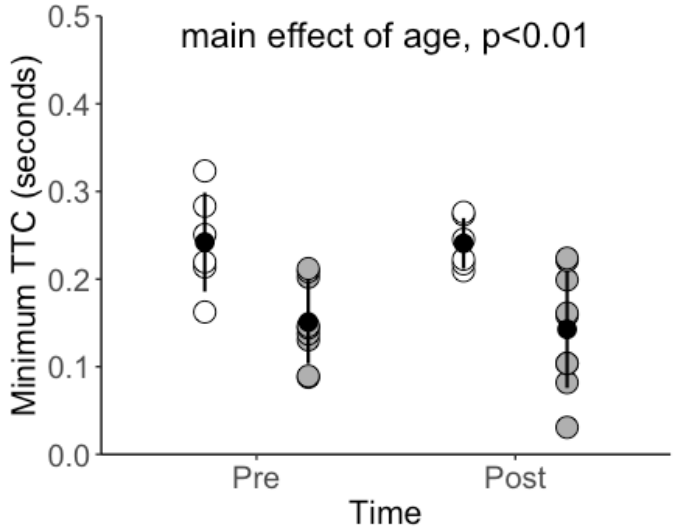


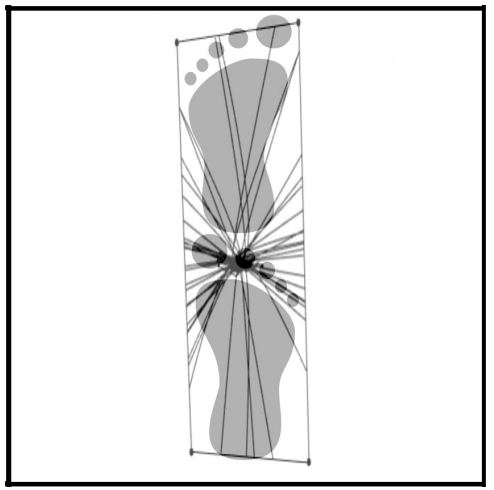
Semi-tandem





Full-tandem





Younger Adults

Older Adults

Mean ± SD

Discussion and Conclusions

Time alone does not capture aging related declines in postural control

Reduced TTC in the older adults suggests an increased risk of falls

TTC is an informative metric that accounts for both the spatial and temporal domains of postural control

Future studies should explore the effect of other types of physical activity on postural control, such as localized fatiguing protocols

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