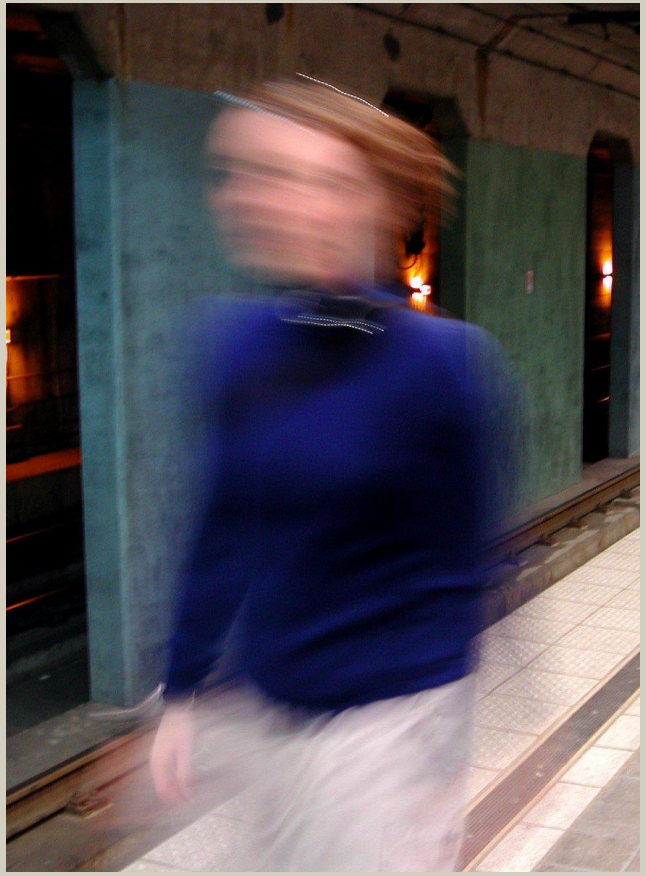
THE ROLE OF TERRAIN AND BALANCE CONFIDENCE ON GAIT SPEED AND SPATIOTEMPORAL MEASURES

Capstone Research by
Stacy Harris and Alan Levinson

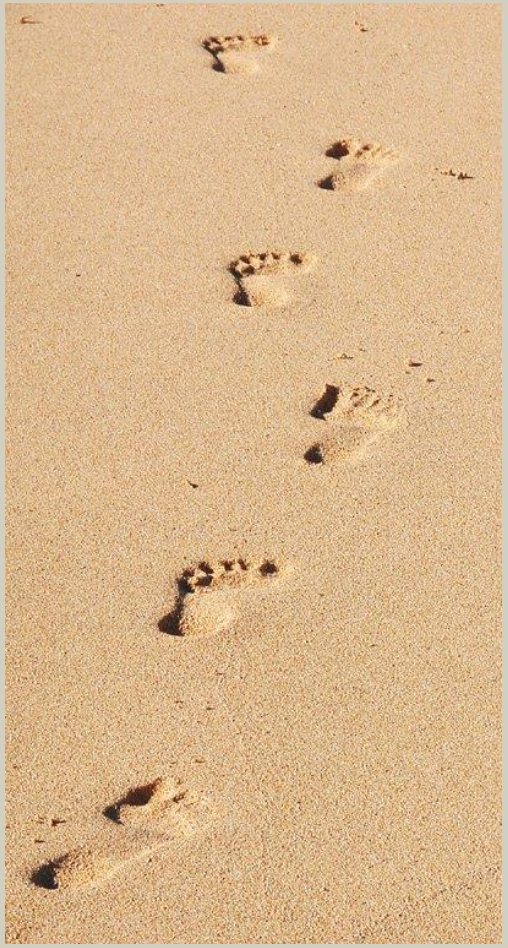
THE SIGNIFICANCE OF GAIT SPEED & CONFIDENCE



- Goal for Physical Therapists to improve gait in people with mobility deficits.
- Predicts health status and disability.[1]
- Good measure of mobility performance.[2]
- Normative values established using the 10 meter walk test in healthy adults.[3]
- Greater confidence may be associated with greater mobility

WHY LOOK AT SPATIOTEMPORAL MEASURES & CONFIDENCE?

- To ↑ gait speed, ↑ step length and/or cadence.[4,5]
- Changes in step length and/or cadence[5,7,8]
- Walking downhill and uphill[9]
- Confidence is associated with improved functional ability and mobility performance.[6]



WHAT ABOUT OUTDOOR TERRAINS?

- Full participation in life roles and activities.
- No studies compare indoor speed to outdoor community terrain.

If we understand how step length and cadence change on various surfaces, it can help us to better inform our instruction and treatment!

PURPOSE

The **purpose:**

To explore change in gait speed between smooth, firm clinic setting and various outdoor terrains, and determine influence of balance confidence.

Hypothesis:

Gait speed will be reduced in outdoor terrains, and those with decreased confidence will demonstrate a greater reduction in gait speed, step length, and cadence.

SUBJECTS

- 49 participants:
  - 27 female
  - Average Age 65.2
- Diagnoses:
  - 19 with Parkinson's or Stroke
  - 23 with MSK complaints or Trauma
  - 7 other conditions
- 23 with a history of Falls:
  - Range from 1 to 12 in the past year
  - 2.4 falls on average, per faller
- Assistive Devices, orthotics, prosthetics:
  - 8 used cane (1 used knee brace)
  - 2 used Bioness
  - 2 wore ankle braces
  - 1 wore an ankle foot orthotic
  - 1 used a trans-femoral prosthetic
  - 1 used bilateral trans-tibial prosthetics
  - 1 participant had a shoe lift

DATA COLLECTION

- 10 Meter Walk Test –
  - At the CRC gym – 1 Trial
- 5 Outdoor Terrains –
  - Community Challenge Course –
    1st loop, gravel downhill, 2nd loop, gravel uphill
- Video recorded of all participants
- Activities Balance Confidence Scale
  - Collected for 26 participants

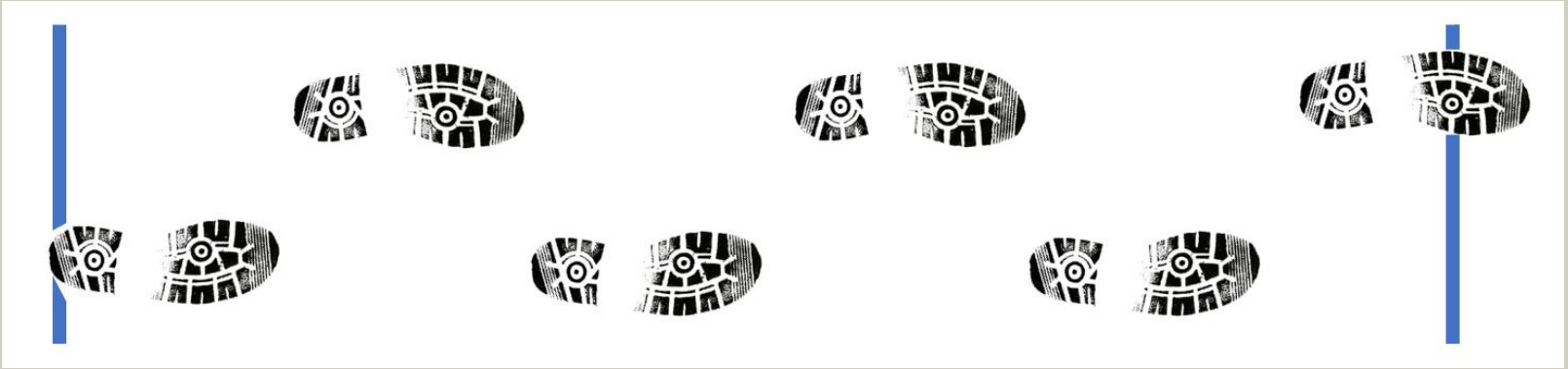
Table 1

Terrain	Distance (meters)
10MWT (indoors)	10
Large Pavers	21.9
Sand	4.2
Gravel (up/downhill)	11.9
Mulch	6
Small Pavers	5.8

Participants used the same assistive device, prosthetic, and/or orthotic for all data collection.

DATA PROCESSING

- Start and Finish times and Number of steps recorded for each participant.
- Calculations using data
  - Time for each terrain in seconds (finish – start)
  - Average gait speed in m/s (distance/time)
  - Cadence in number of steps per minute (steps/time)
  - Step length in meters (distance/steps)



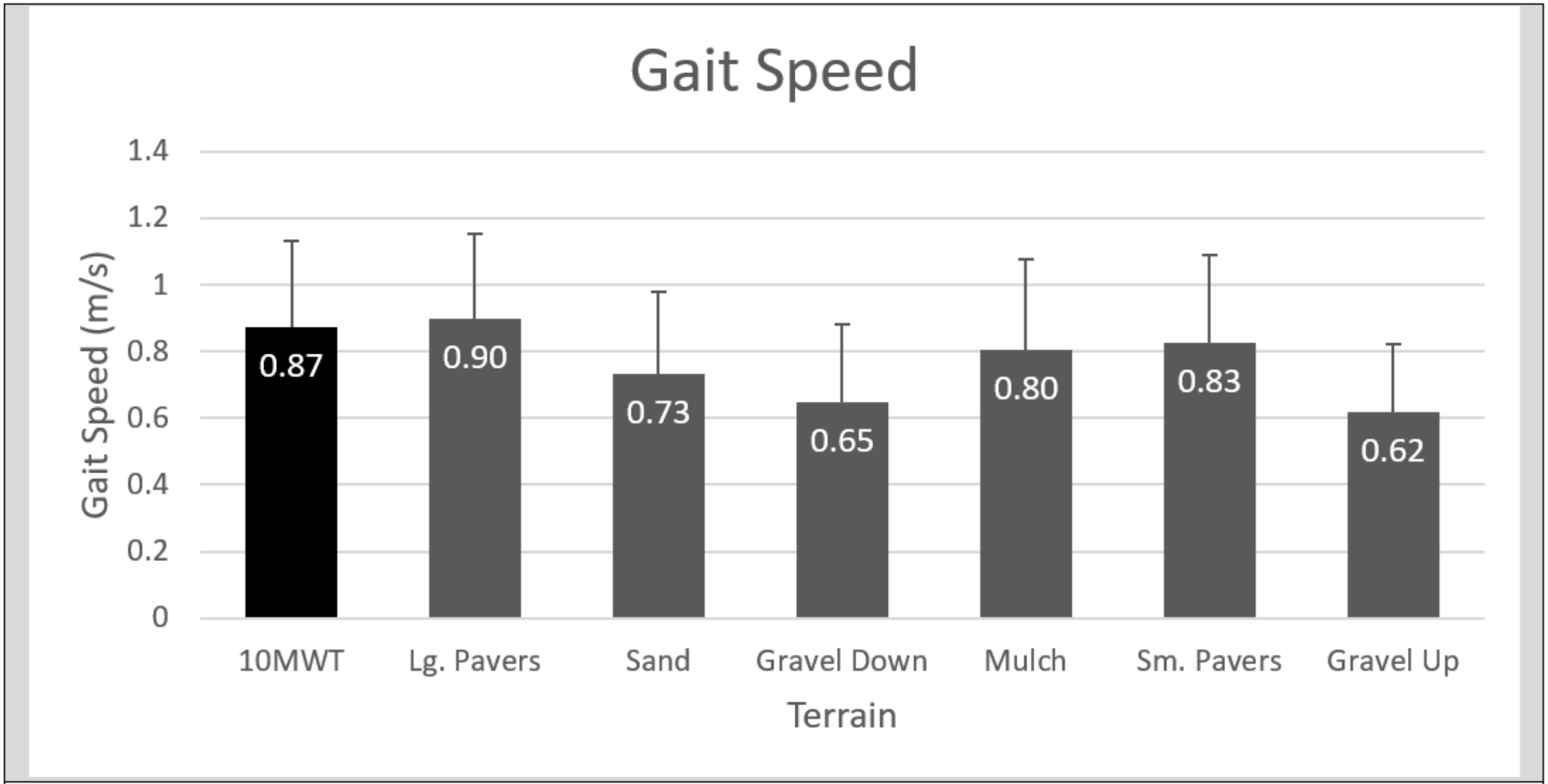
STATISTICAL ANALYSIS – GAIT PARAMETERS

- There was a significant main effect across all terrains for
  - Gait Speed ($p < 0.001$; $\eta_p^2 = 0.644$)
  - Cadence ($p < 0.001$; $\eta_p^2 = 0.323$)
  - Step length ($p < 0.001$; $\eta_p^2 = 0.597$)

- Gait speed was significantly slower on **sand, mulch, and going up and downhill on gravel** (all $p < 0.023$).
  - No significant change on large and small pavers

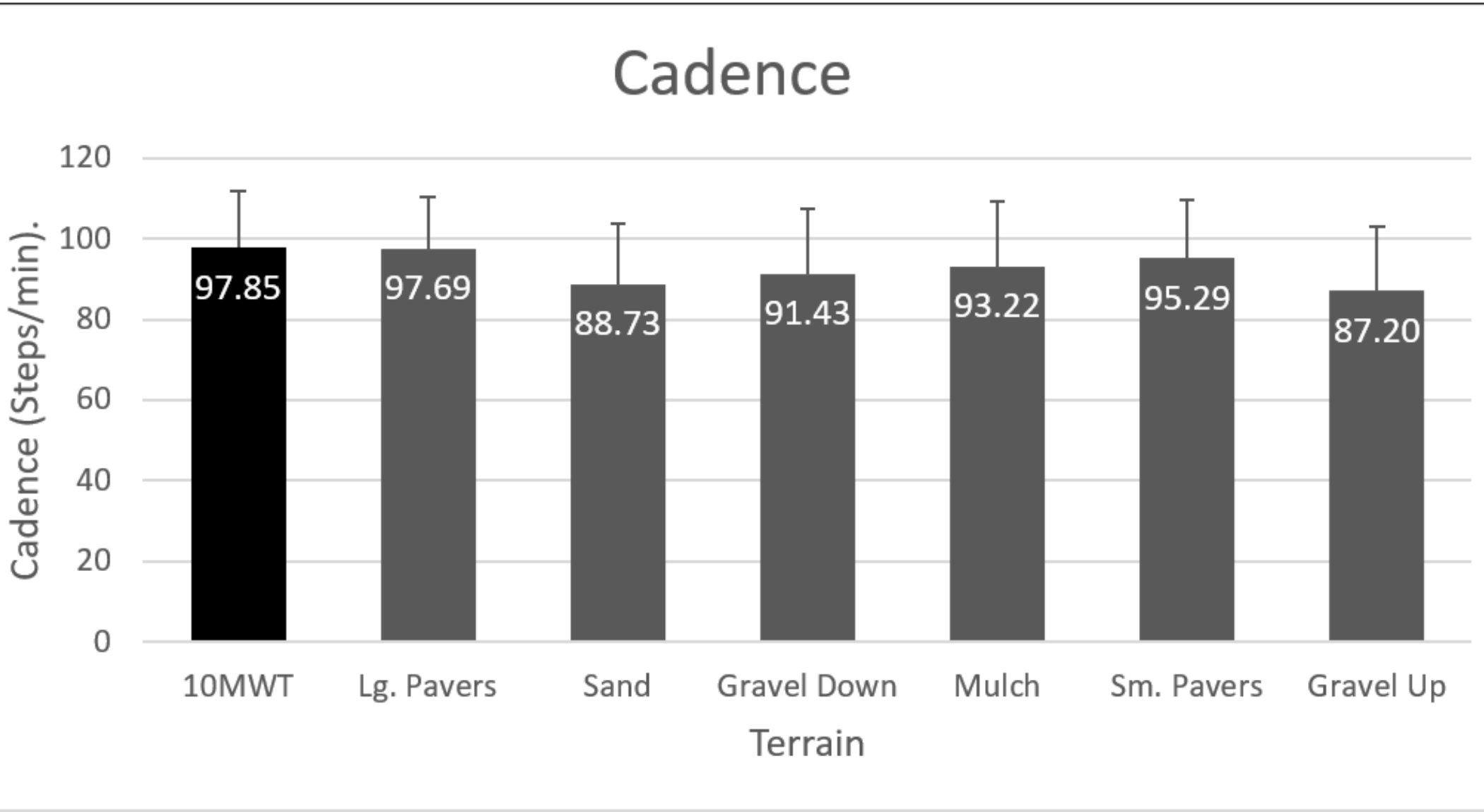
- Cadence and step length were significantly reduced on **sand and going up and downhill on gravel** (all $p < 0.006$ and $p < 0.017$, respectively).
  - No significant change on mulch, large pavers, or small pavers

Figure 1



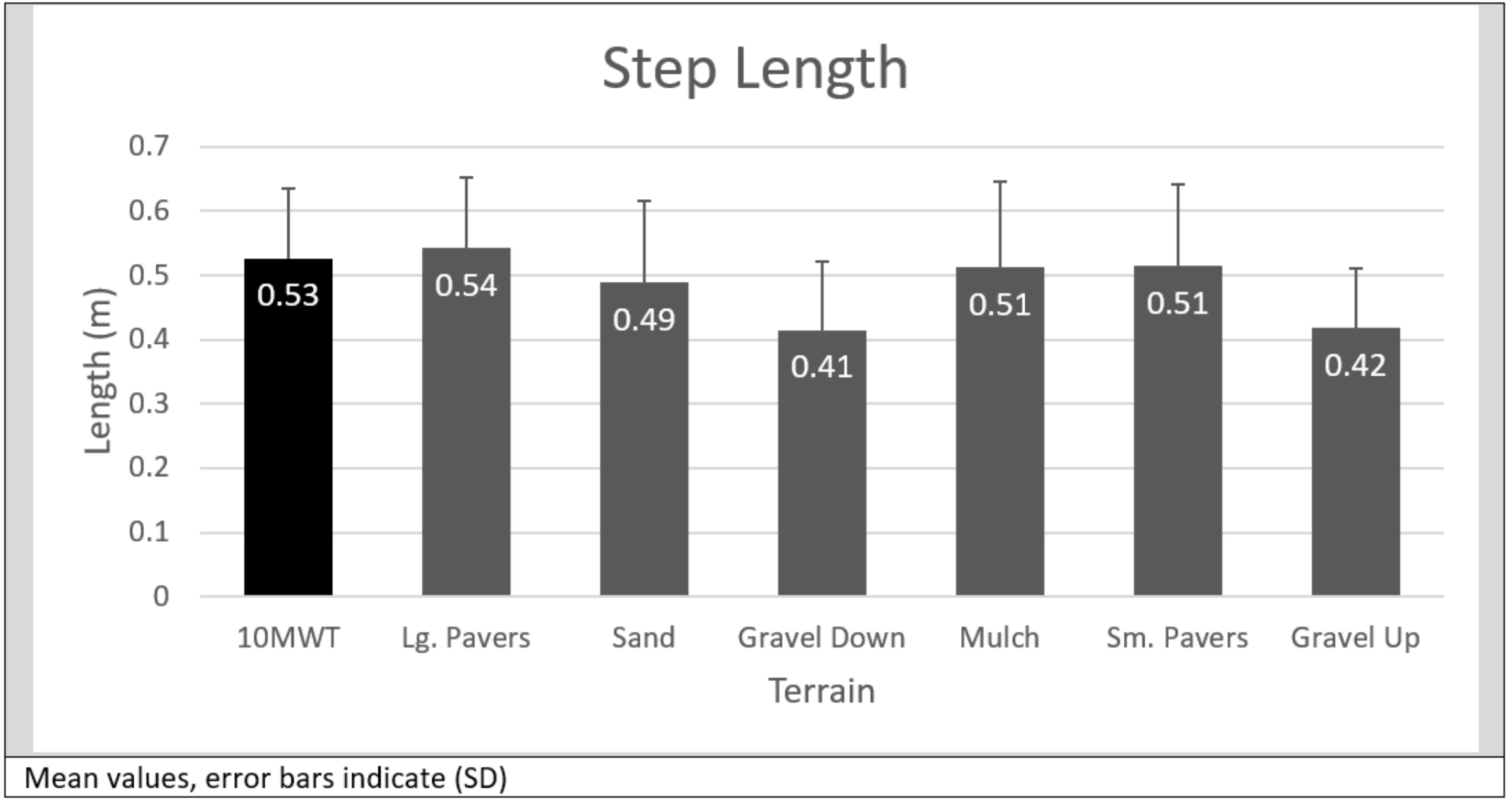
Mean values, error bars indicate (SD)

Figure 2



Mean values, error bars indicate (SD)

Figure 3



Mean values, error bars indicate (SD)

STATISTICAL ANALYSIS – STEP LENGTH/CADENCE

- Step length Δ + cadence Δ → Gait speed Δ
  - From 10MWT condition to the **sand, mulch, and up and downhill gravel**

- Combination of step length and cadence changes accounted for
  - >94% of the variance, 10MWT → **sand** speed ($p < 0.001$, $R^2 = 0.938$)
    → **mulch** speed ($p < 0.001$, $R^2 = 0.962$)
    → **downhill gravel** speed ($p < 0.001$, $R^2 = 0.937$)
    → **uphill gravel** speed ($p < 0.001$, $R^2 = 0.938$)

STATISTICAL ANALYSIS – CONFIDENCE

- Balance Confidence (ABC) is NOT related to changes in mobility measures
  - Gait speed (all $p > 0.202$); Step length (all $p > 0.064$); Cadence (all $p > 0.507$)

- Clinic Speed (10MWT) IS correlated to Δ in velocity
  - Sand ($p=0.009$; $r=0.370$)
  - Gravel Downhill ($p=0.001$; $r=0.449$) and Gravel Uphill ($p<0.001$; $r=0.619$)

- Clinic Speed (10MWT) IS correlated to Δ step length
  - Gravel Downhill ($p=0.001$; $r=0.558$) and Gravel Uphill ($p=0.014$; $r=0.348$)

WHAT DOES THIS MEAN FOR PT?

- The gait speed of patients observed indoors during a 10MWT is not representative of the speed they will use when walking on various outdoor terrains.

- Physical therapists should be training patients on the terrains they expect them to encounter once they reenter the community along with other interventions targeting dynamic balance and strength.

- Patient's perceived confidence does not predict mobility performance in the community. Caution is required to reduce over-confidence errors and under- confidence reduction of activity.

ACKNOWLEDGEMENTS

UNC Center for Rehabilitation Care – Physical Therapists and Staff

Catherine “CJ” Jacobs, PT, DPT

Dr. Michael Lewek, PT, PhD

REFERENCES:

All Images from www.freeimages.com

1. Guralnik JM, Ferrucci L, Pieper CF, et al. Lower extremity function and subsequent disability: consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance battery. J Gerontol A Biol Sci Med Sci 2000;55(4):M221-31.

2. Barnett C, Vanicek N, Polman R, et al. Kinematic gait adaptations in unilateral transtibial amputees during rehabilitation. Prosthet Orthot Int 2009;33(2):135-147. doi:10.1080/03093640902751762.

3. Bohannon RW. Comfortable and maximum walking speed of adults aged 20-79 years: reference values and determinants. Age Ageing 1997;26(1):15-19.

4. Zijlstra W, Rutgers AWF, Hof AL, Van Weerden TW. Voluntary and involuntary adaptation of walking to temporal and spatial constraints. Gait Posture 1995;3(1):13-18. doi:10.1016/0966-6362(95)90804-2.

5. Oberg T, Karsznia A, Oberg K. Basic gait parameters: reference data for normal subjects, 10-79 years of age. J Rehabil Res Dev 1993;30(2):210-223.

6. Myers AM, Powell LE, Maki BE, Holliday PJ, Brawley LR, Sherk W. Psychological indicators of balance confidence: relationship to actual and perceived abilities. *J Gerontol A Biol Sci Med Sci* 1996;51(1):M37-43.

7. MacLellan MJ, Patla AE. Adaptations of walking pattern on a compliant surface to regulate dynamic stability. Exp Brain Res 2006;173(3):521-530. doi:10.1007/s00221-006-0399-5.

8. Hausdorff JM. Gait dynamics, fractals and falls: finding meaning in the stride-to-stride fluctuations of human walking. Hum Mov Sci 2007;26(4):555-589. doi:10.1016/j.humov.2007.05.003.

9. Sun J, Walters M, Svensson N, Lloyd D. The influence of surface slope on human gait characteristics: a study of urban pedestrians walking on an inclined surface. Ergonomics 1996;39(4):677-692. doi:10.1080/00140139608964489.