

The Efficacy of FES Cycling for Improving Physiological Function in People with MS with Severe Mobility Impairment

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Disclosures

None to declare



Exercise and MS

- Exercise training has been an effective method for improving:
 - Walking
 - Physical fitness
 - Fatigue
 - Mood
 - QoL

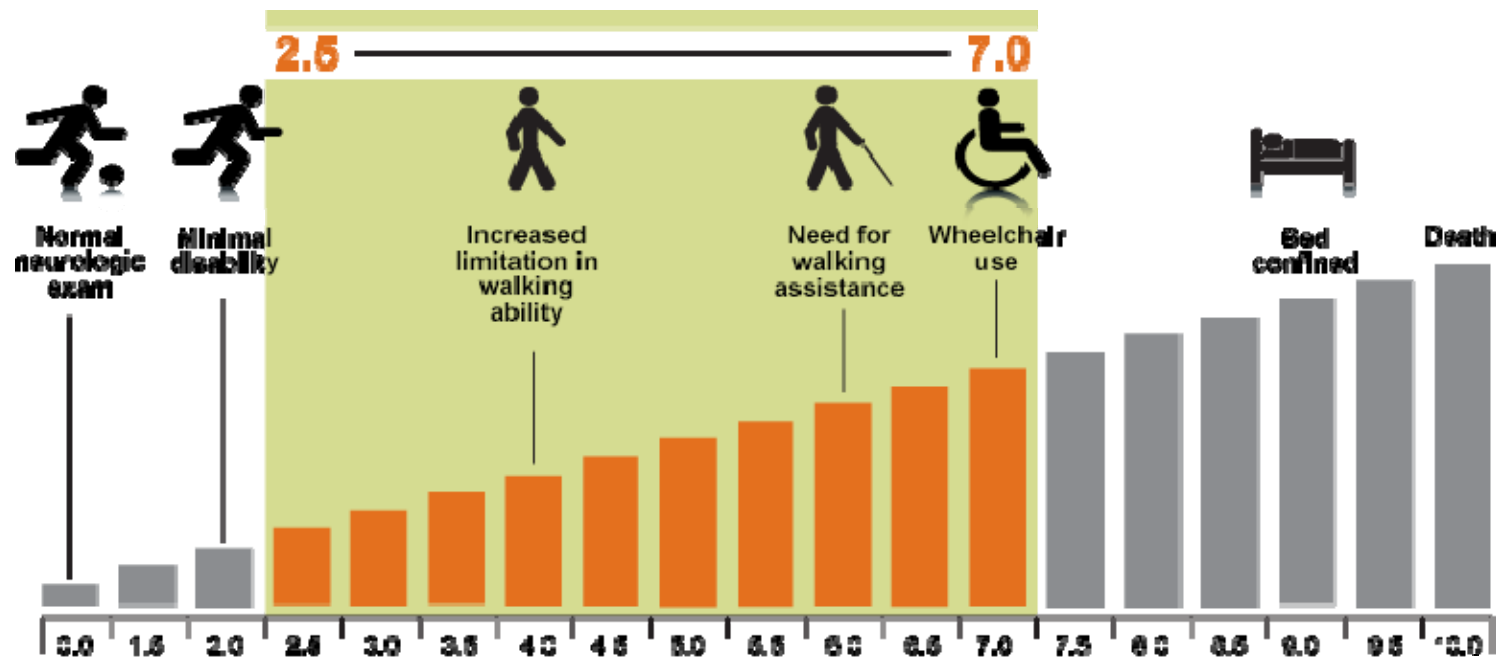


Exercise and MS

- Previous research primarily focused on individuals with mild to moderate disability
- Conventional exercise approaches may present challenges
- Alternative, adapted exercise modalities should be considered



Mobility Disability in MS



Functional Electrical Stimulation (FES)

- Exercise modality coupled with an electrical stimulation
 - FES-cycling
- Benefits reported in other populations with mobility impairment
 - Spinal cord injury and stroke
- Preliminary evidence for safety and efficacy of FES-cycling in MS



MS and FES

| Outcome Measure | Baseline | Change after 6 months | Percentage change |
|----------------------|----------|-----------------------|-------------------|
| T25FW (sec) | 27.3 | 17.4 | 36% |
| 2MW (m) | 35.4 | 39.9 | 13% |
| TUG (sec) | 36.5 | 28.4 | -22% |
| SSWS (m/min) | 15 | 20.3 | 35% |
| Knee Extension (lbs) | 40.8 | 46.9 | 15% |
| Knee Flexion (lbs) | 22.7 | 27.1 | 19% |
| SF-36 | 41.8 | 47.3 | 13% |



Objectives

- Single-blinded, randomized pilot clinical trial for examining the efficacy of 6-months of supervised FES cycling versus a passive cycling condition
- Primary outcomes: walking and physical fitness



Methods: Participants

- Inclusion criteria

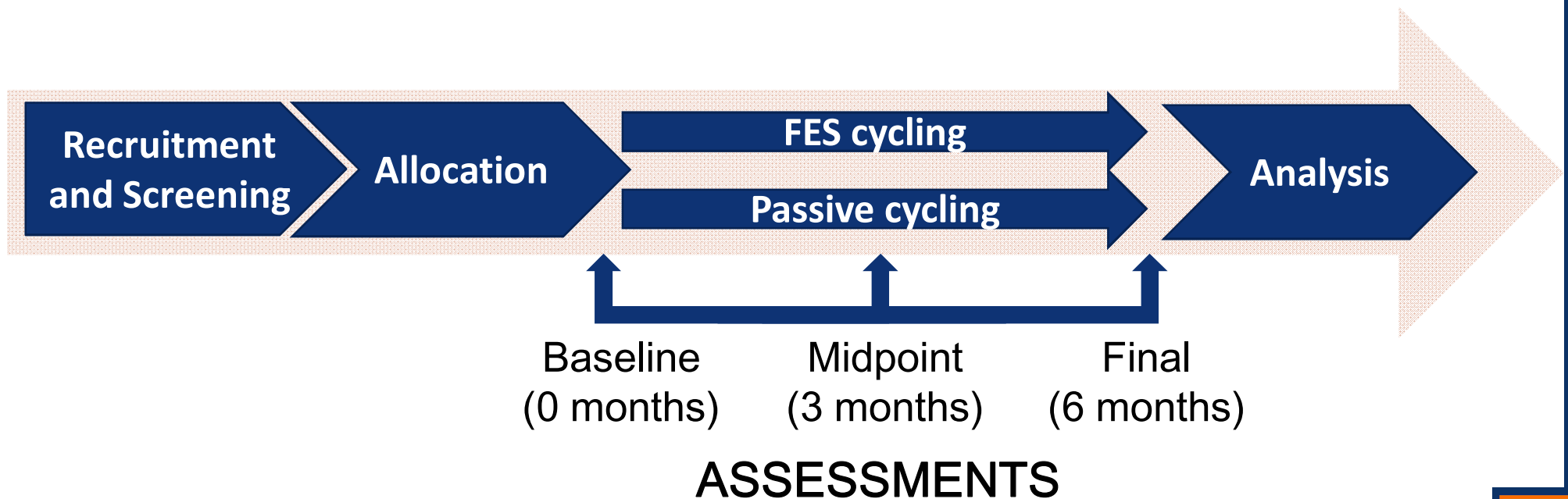
- EDSS=5.5 to 6.5
- physically inactive
- relapse free ≥ 30 days
- confirmed diagnosis of MS
- asymptomatic
- physician approval
- ability to tolerate FES cycling.

- Exclusion Criteria

- epilepsy
- a pacemaker
- an implanted defibrillator
- an unstable fracture
- surgical screws or pins



Methods: Design



Methods: Intervention



- FES Group: Received stim
- Passive Group: No voluntary cycling
- Effects sizes calculated (Cohen's d) to determine intervention effects



Methods: Outcomes

- Walking Ability
 - Walking speed → Timed 25-Foot Walk (T25FW)
 - Walking endurance → 2-minute walk (2MW)
 - Agility → Timed Up-and-Go test (TUG)



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- Physical Fitness
 - Muscular strength
 - Aerobic capacity



Results: Demographics

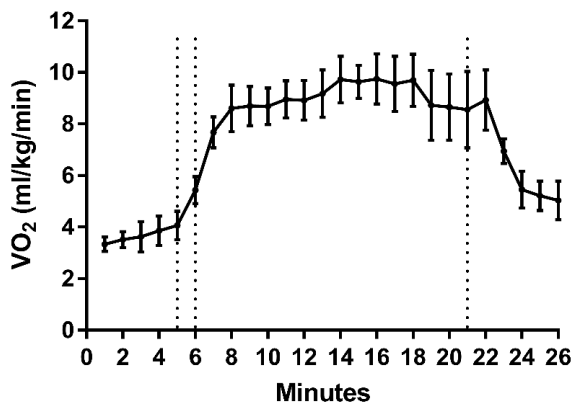
| | FES (n=4) | Passive (n=4) | p-value |
|------------------------------------|--------------|---------------|---------|
| Demographic Characteristics | | | |
| Age, y | 57.3 (6.0) | 48.5 (7.7) | .12 |
| Sex, n | | | |
| Women | 3 | 3 | - |
| Men | 1 | 1 | - |
| Height, cm | 161.1 (10.4) | 160.5 (9.2) | .93 |
| Weight, kg | 70.6 (19.5) | 85.8 (46.0) | .56 |
| BMI, kg/m ² | 27.2 (7.4) | 32.1 (13.9) | .56 |
| Clinical Characteristics | | | |
| EDSS | 6.1 (0.5) | 6.25 (0.3) | .67 |
| Disease Duration, y | 22.3 (5.3) | 20.8 (8.5) | .77 |



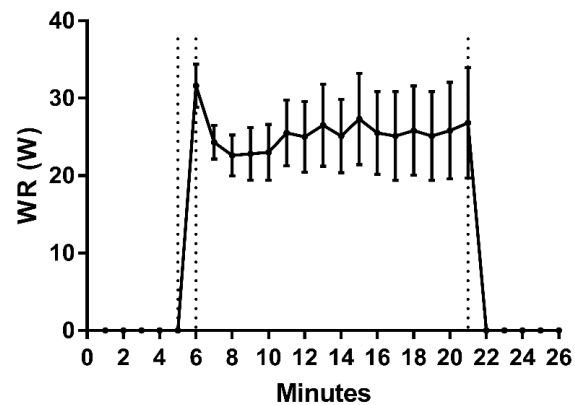
Results: Training

- Average compliance=84.2%
- Submaximal exercise session was characterized

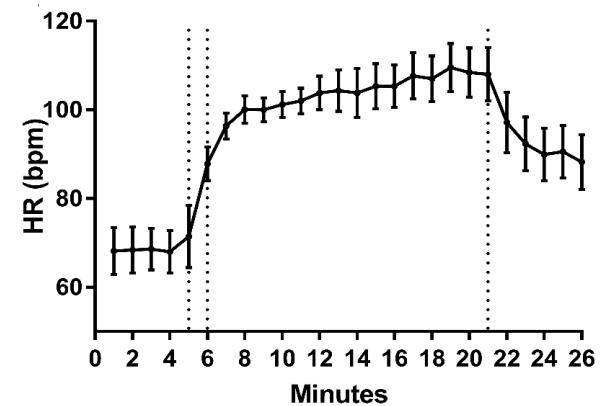
63.5% of VO_{2peak}



57.3% of WR_{peak}

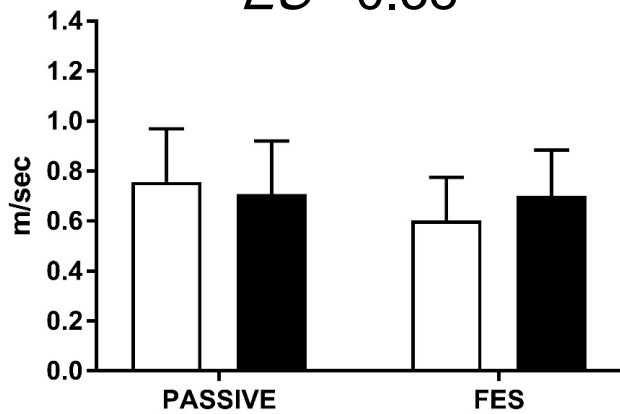


76.4% of HR_{peak}

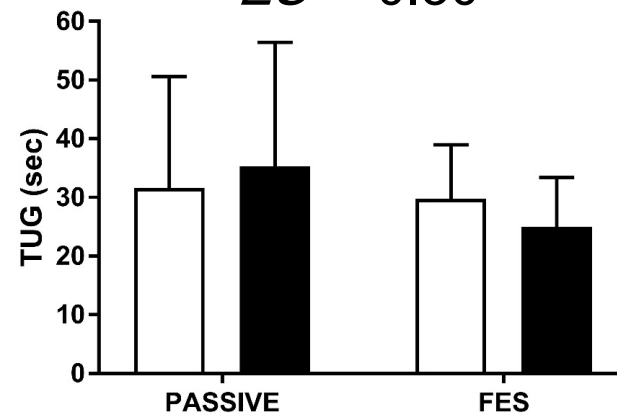


Results: Mobility

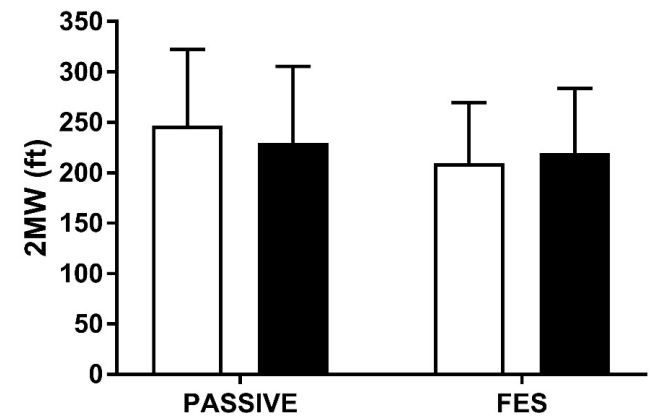
$ES = 0.38$



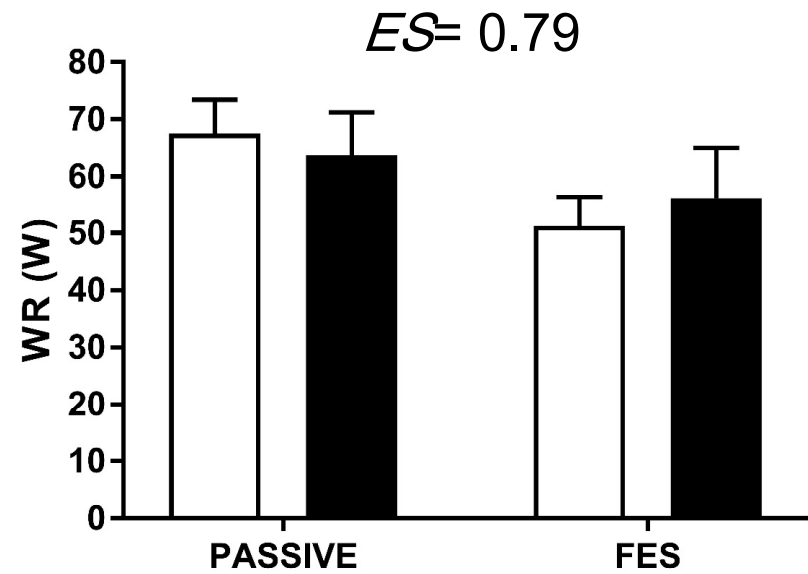
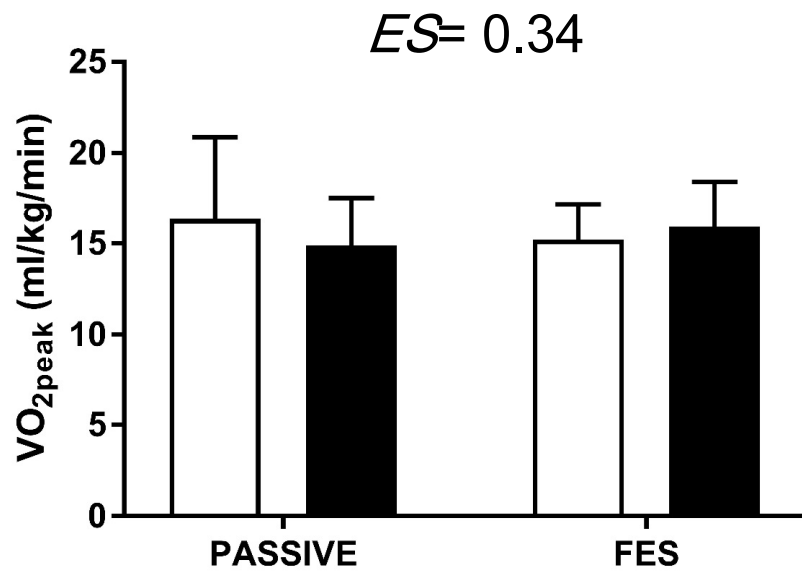
$ES = -0.30$



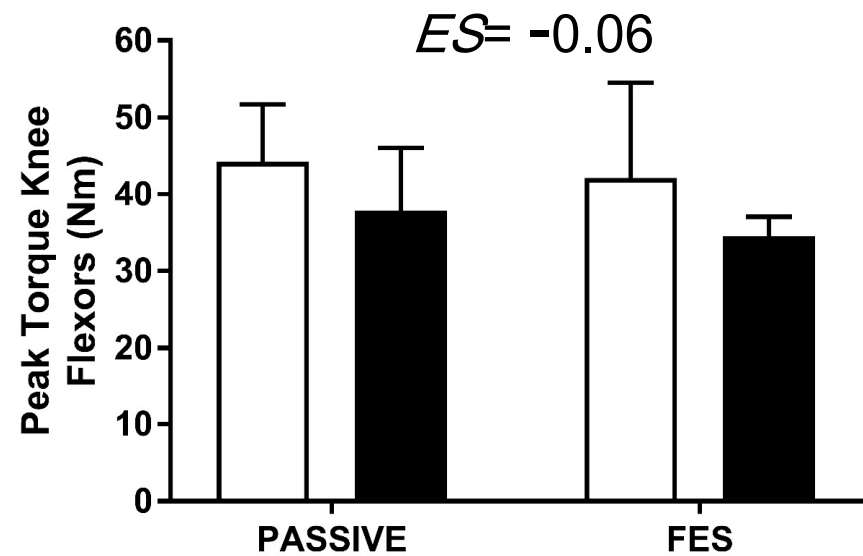
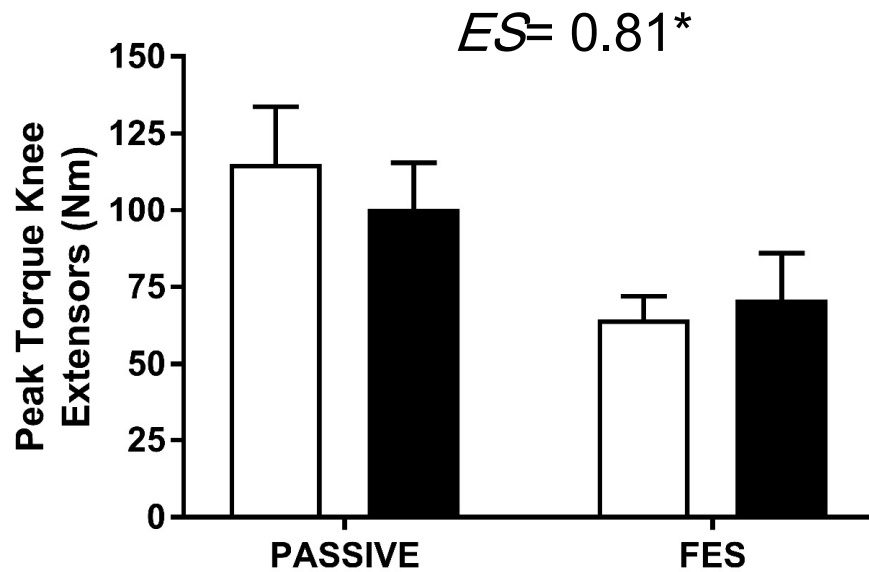
$ES = 0.20^*$



Results: Fitness



Results: Fitness



Discussion: Mobility

FES group

- Improvements/maintenance of all mobility outcome
- Consistent with previous literature



- Result of increased physical fitness

Passive group

- Decline in all mobility outcomes



- Aerobic capacity and lower limb strength are associated with walking performance (Sandroff et al, 2013)



Discussion: Fitness

FES group

- Improved/maintained aerobic fitness
- Improved knee extensor strength



- Prolonged aerobic stimulus contribute to aerobic fitness

- Leg cycling pattern may explain difference in flexor/extensor strength

Passive group

- Decline in all fitness outcomes



- Stimulation of compromised musculature increased muscle recruitment



Conclusions

- FES cycling is an accessible, adapted form of exercise training
- Provides an aerobic exercise stimulus
- External stimulation may recruit compromised muscles
- Improvements/maintenance of mobility and fitness



Acknowledgments



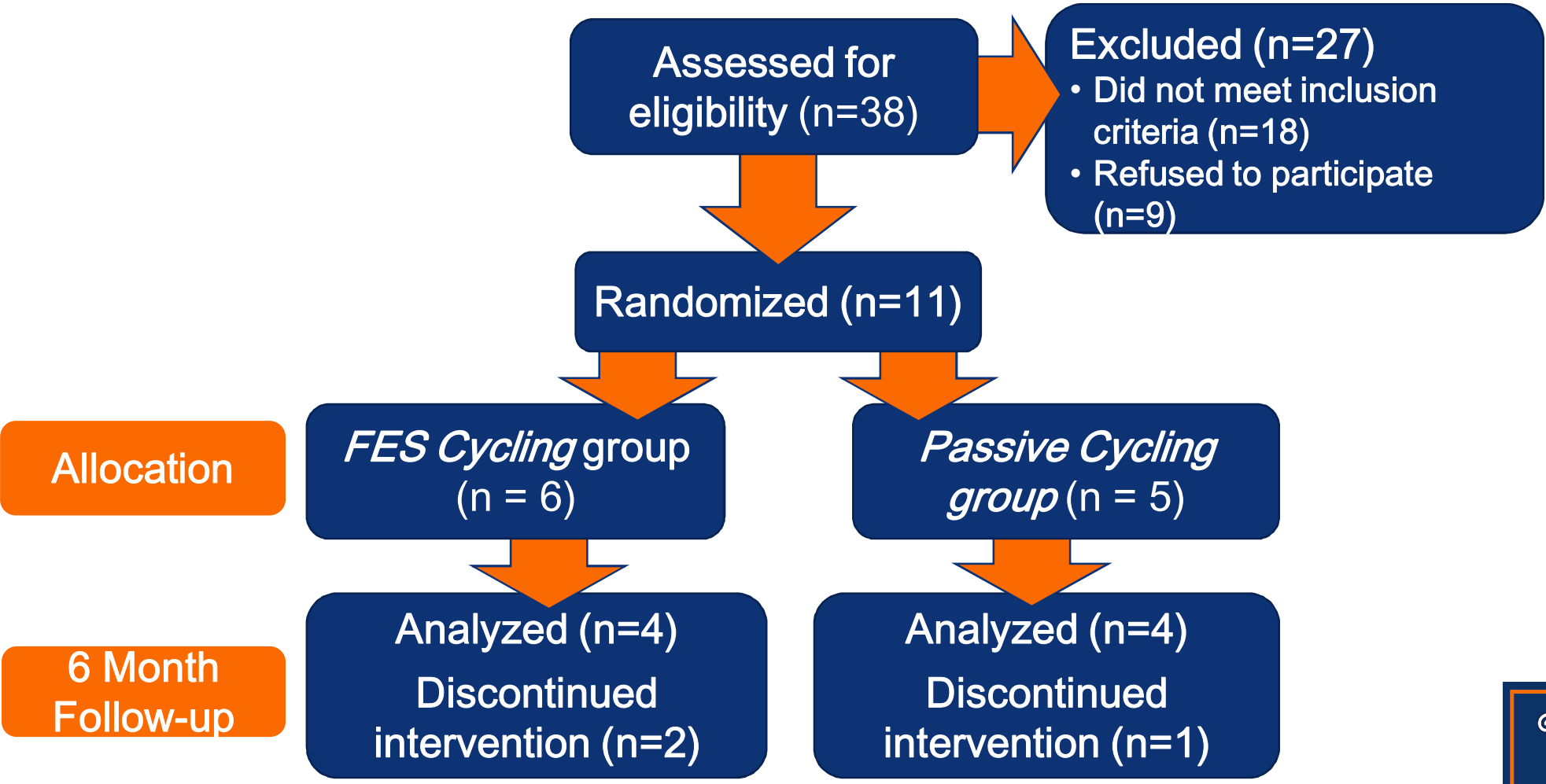
- Clinical Exercise Neuroscience Lab
- Dr. Lara Pilutti

- Exercise Neuroscience Research Lab
- Dr. Robert Motl



Thank you

Questions?



Results: Mobility

FES

| Variable | Baseline | 6 Month Follow Up | Mean Change (0-6) | Effect size (Cohen's d) |
|------------|-------------|-------------------|-------------------|-------------------------|
| T25FW, m/s | 0.60 (0.3) | 0.70 (0.4) | 0.10 | 0.3 |
| TUG, s | 29.7 (18.4) | 25.0 (17.0) | -4.76 | -0.3 |
| 2MW, m | 63.9 (36.6) | 66.9 (39.2) | 3.05 | 0.1 |

Passive

| Variable | Baseline | 6 Month Follow Up | Mean Change (0-6) | Effect size (Cohen's d) |
|------------|-------------|-------------------|-------------------|-------------------------|
| T25FW, m/s | 0.76 (0.4) | 0.71 (0.4) | -0.05 | -0.1 |
| TUG, s | 31.6 (37.9) | 35.3 (42.2) | 3.65 | 0.1 |
| 2MW, m | 75.2 (46.1) | 70.0 (46.3) | -5.18 | -0.1 |



Results: Fitness

FES

| Variable | Baseline | 6 Month Follow Up | Mean Change (0-6) | Effect size (Cohen's d) |
|-----------------------------|-------------|-------------------|-------------------|-------------------------|
| VO ₂ , ml/kg/min | 15.2 (4.0) | 16.0 (5.0) | 0.73 | 0.2 |
| WR, W | 51.3 (10.3) | 56.3 (17.5) | 5.0 | 0.5 |
| TTE, s | 509 (103.7) | 565.8 (169.3) | 56.75 | 0.6 |
| Flexor (Nm) | 42.2 (24.7) | 34.48 | -7.7 | -0.3 |
| Extensor (Nm) | 64.4 (15.1) | 70.9 (30.0) | 6.5 | 0.4 |

Passive

| Variable | Baseline | 6 Month Follow Up | Mean Change (0-6) | Effect size (Cohen's d) |
|-----------------------------|---------------|-------------------|-------------------|-------------------------|
| VO ₂ , ml/kg/min | 16.4 (9.0) | 14.9 (5.3) | -1.5 | -0.2 |
| WR, W | 67.5 (11.9) | 63.8 (14.9) | -3.8 | -0.3 |
| TTE, s | 673.8 (156.5) | 674.5 (151.4) | 0.75 | 0.0 |
| Flexor (Nm) | 44.3 (14.9) | 37.8 (16.5) | -6.5 | -0.4 |
| Extensor (Nm) | 115.2 (37.0) | 100.6 (29.9) | -14.6 | -0.4 |

