High-intensity low volume functional electrical stimulation-cycling exercise improves muscle performance and ambulation capacity in hospitalized patients: randomized controlled trial

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INTRODUCTION

- Acquired muscle weakness is a prevalent complication during hospitalization.
- FES-cycling is a tool with the potential to improve physical exercise in patients constrained to bed rest.
- Primary aim: to establish the effects of a high-intensity, low-volume FES-cycling exercise on muscle performance. Secondary aim: to determine the effects of this exercise regimen on ambulation capacity.

METHODS

Study Design

- Randomized clinical trial (sealed envelopes in a 1:1 ratio to either the FES-cycling group or a control group). Patients were paired before randomization (age, sex and ambulation capacity);
- Initial evaluation, intervention, and post-intervention evaluation.
- Same elapsed times between assessments in both groups.

Participants

- 22 patients admitted to a high complexity ward were enrolled. The sample size calculation indicated a minimum of 14 patients (7 in each group). Inclusion criteria: clinical signs of muscle weakness. Exclusion criteria: no clinical conditions for FES-cycling exercise, less than 3 FES-cycling exercise sessions or hospital discharge in less than 3 days after the initial evaluation.

Ambulation capacity

- Independent ambulation: able to ambulate 10 steps without support;
- Ambulation with support: need support (walker, stick, other person assistance, etc.) to ambulate 10 steps;
- Bed-restricted: Not able to get up from the bed or ambulate 10 steps, even with support (no bed-restricted patient had a history of being bedbound before hospitalization).

Muscle performance assessment

- A previously validated protocol for hospitalized patients.



Intervention

- Both groups received the usual routine hospital care. Beyond usual care, the intervention group received the high-intensity low-volume FES-cycling exercise protocol.
- Pulse intensity up to 190mA, width up to 800µs, 75Hz frequency and 15 RPM for 10 minutes.



Outcomes

- Torque (strength), power output, stimulation cost (neuromuscular efficiency), and ambulation capacity.

Statistical analysis

- Shapiro-Wilk, Fischer, Unpaired t test, Mann-Whitney, Chi-square, effect size.

RESULTS

Table 1: Patient's Baseline Characteristics and Protocol Development.

Variable	FES-cycling (n = 8)	Control (n = 8)	P value
Sex (male/female)	3/5	3/5	1.0
Age (years)	57 ± 18	54 ± 16	0.7626
Ambulation capacity (n)			
Bed restriction	6	6	1.0
Ambulation with support	2	2	1.0
Independent ambulation	0	0	1.0
Muscle performance			
Torque (Nm)	3.67 (2.75 – 4.55)	3.59 (2.90 – 5.51)	0.5737
Power (watts)	6.41 (5.62 – 7.78)	6.61 (5.82 – 7.48)	0.7983
Stimulation cost (x 10^3, µC/watt)	5.73 (4.66 – 12.17)	8.45 (2.70 – 13.82)	0.8785
Protocol development			
Elapsed time Between Evaluations (days)	8 ± 4	8 ± 4	1.0
FES-Cycling Sessions (n)	5 ± 2	-	-

Data are presented as mean ± standard deviation or median (interquartile range)

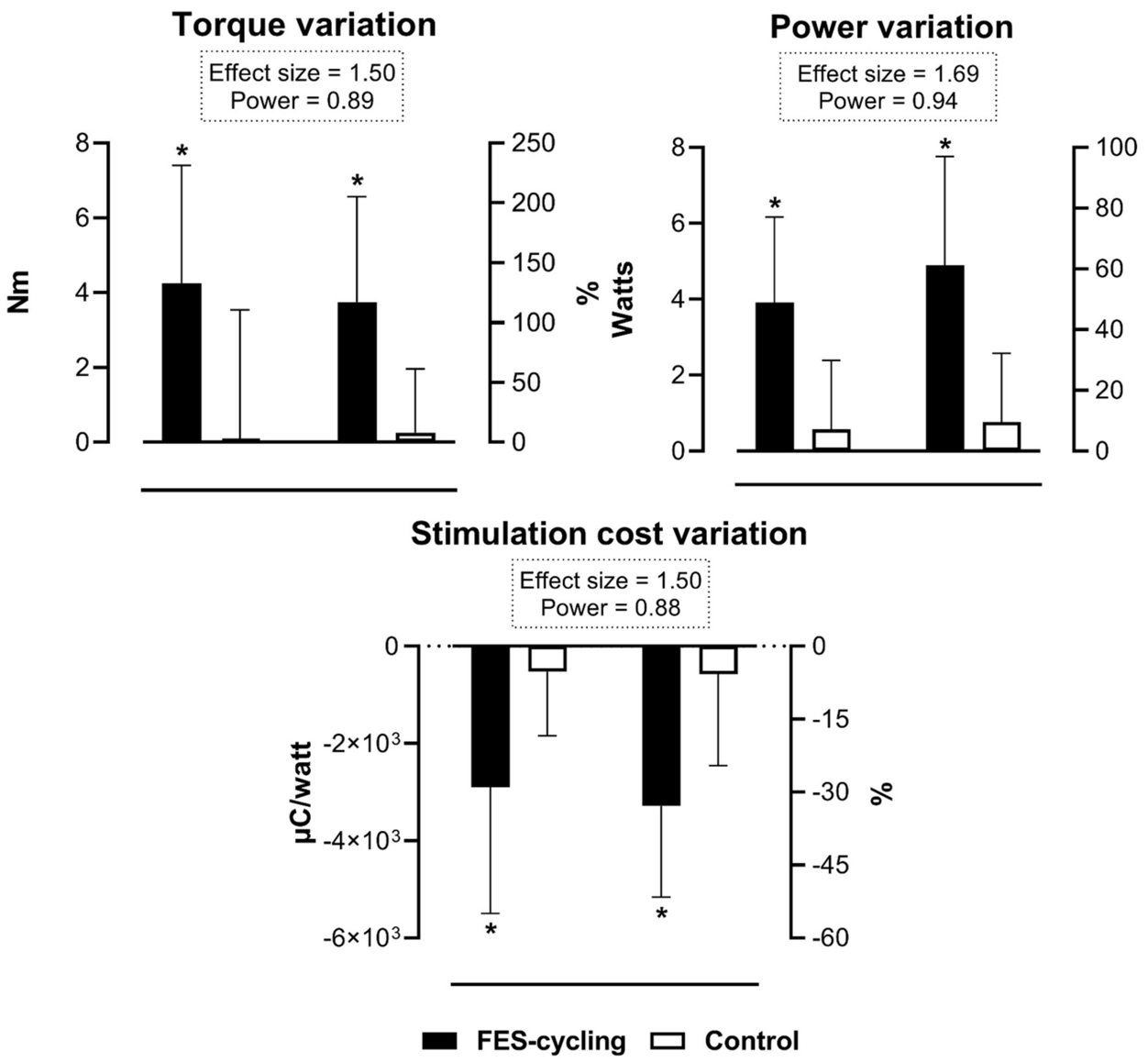


Figure 1: Variation in muscle performance after treatment. Data are presented as means ± standard deviations. *P < 0.05 indicates statistical significance.

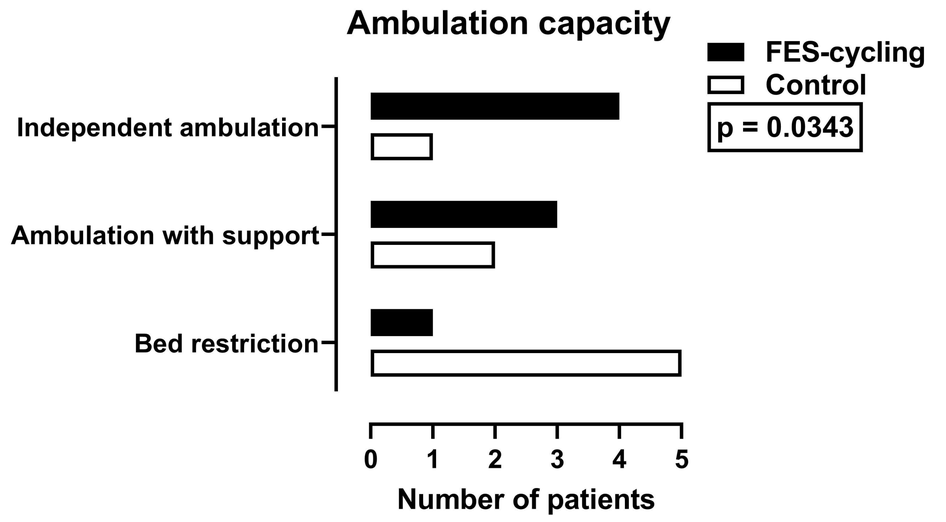


Figure 2: Ambulation capacity outcomes following treatment.

CONCLUSIONS

High-intensity low volume FES-cycling exercise increased the strength, power and neuromuscular efficiency in hospitalized patients. Ambulation capacity was also improved.