

Assessing Motor Fatigability Using a 10-second Hop Test in People with Multiple Sclerosis

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Introduction

- People with multiple sclerosis (PwMS) can be more susceptible to motor fatigue than healthy individuals [1]
- Measuring fatigability has traditionally been difficult due to the necessity of an endurance load over an extended measurement duration (e.g., six-minute walk test)
- A 10-second hop test (10sHT) may be a quick, objective method to assess motor fatigability in PwMS

Objective

- Compare overall performance and motor fatigability between individuals who were motor normal and motor impaired during a 10sHT assessed using smart shoe insoles (Insoles)

Methods

Participants & Assessment

- Healthy (n = 18) and PwMS (n = 40) recruited from the University of Ottawa and the Technical University of Dresden, respectively
- Using the Expanded Disability Status Scale (EDSS), participants were assigned to one of two groups (Table 1)

Table 1. The criteria and divisions of the motor normal and motor impaired groups.

Group	Abbreviation	Criteria	n	No. of Healthy / PwMS
Motor normal	M _{Norm}	EDSS ≤ 1.5	23	18 healthy / 5 PwMS
Motor impaired	M _{Imp}	EDSS ≥ 2	35	35 PwMS

- Each participant performed the 10sHT with the same instructions:
 - Keep hands on hips (Figure 1)
 - Hop repeatedly as high and as fast as possible for 10 seconds
- Eight metrics from each jump were summed or averaged:
 - Across the trial, to compare overall trial performance
 - Across four, 2.5-second time blocks, then fit with linear regression to compare motor fatigability

Instrumentation

- Smart Insoles (ReGo, Moticon, Germany; 50 Hz; Figure 2) streamed raw pressure, gyroscope, and accelerometer data to a jump measurement platform (Celestra Health Systems, Canada)

Methods (continued)



Figure 1. A participant performing the 10sHT, at the bottom of a jump (left) and in mid-air during the flight phase (right).



Figure 2. Smart insoles with pressure, gyroscope, and accelerometer sensors.

Results

- A MANOVA revealed a main effect of group ($p < 0.001$)

Overall Trial Post-hoc Comparison

- Benjamini Hochberg-corrected unpaired t -tests revealed significant differences in 2 of 8 overall metrics (Table 2)

Table 2. The mean (standard deviation) for M_{Norm} and M_{Imp} subgroups. **Bold** indicates significance at $\alpha = 0.05$ after correction.

Metric	M _{Norm}	M _{Imp}	p -value
Jump count (no. jumps)	17.43 (7.30)	11.57 (3.88)	0.001
Propulsive time (s)	0.14 (0.04)	0.16 (0.04)	0.074
Flight time (s)	0.23 (0.11)	0.25 (0.06)	0.271
Ground contact time (s)	6.64 (1.05)	7.10 (1.03)	0.107
Jump height (m)	0.08 (0.06)	0.08 (0.04)	0.622
Peak force (N/kg)	31.88 (10.82)	23.36 (6.13)	0.002
Net propulsive impulse (N-s)	93.08 (47.44)	102.29 (21.26)	0.389
Average mechanical power (W/kg)	9.72 (4.98)	10.01 (3.30)	0.808

Motor Fatigability Post-hoc Comparison

- Benjamini Hochberg-corrected Mann-Whitney U tests revealed significant differences in 2 of 8 motor fatigability metrics (Table 3)

Table 3. The median linear slope (interquartile range) for M_{Norm} and M_{Imp} subgroups. Only the statistically significant comparisons at $\alpha = 0.05$ (after correction) are shown.

Metric	M _{Norm}	M _{Imp}	p -value
Slope of jump count (no. jumps per 2.5 s)	0.40 (0.15 – 0.60)	0.20 (-0.05 – 0.45)	0.048
Slope of peak force (N/kg per 2.5 s)	0.30 (-0.76 – 1.48)	-0.68 (-1.23 – -0.03)	0.013

Results (continued)

- For jump count, M_{Norm} showed a greater positive slope in the number of jumps per 2.5-second time block than M_{Imp} (Figure 3)
- Peak force increased throughout the trial in M_{Norm}, while it decreased throughout trial in M_{Imp} (Figure 3)

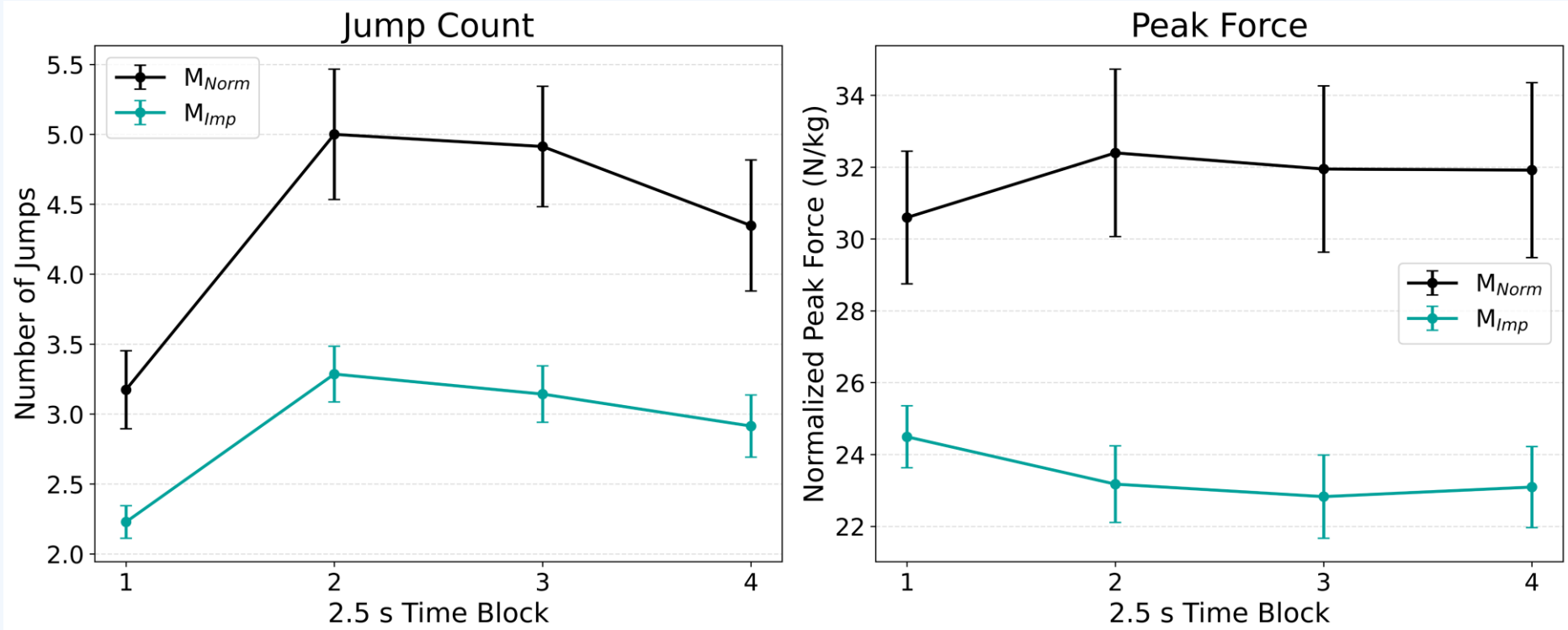


Figure 3. The change in jump count (left) and peak force (right) in M_{Norm} and M_{Imp} across the four, 2.5-second time blocks. The error bars indicate standard deviation.

Conclusion

- Motor fatigability is a symptom amongst PwMS that can be measured to provide insight into disease progression [1]
- Insole-measured 10sHT revealed differences between impairment groups in overall performance and motor fatigability trends in jumping rate and peak force, supporting further validation as a brief assessment of motor fatigability
- Establishing clinical suitability and capacity to monitor disease progression needed before inclusion in an assessment battery for PwMS, such as the Dresden Multidimensional Assessment [2, 3]

Disclosures

This study was supported by the Ontario Centre of Innovation Collaborate 2 Commercialize (35281). VCHC was supported by the National Research Council Canada Industrial Research Assistance Program (1019330). MPM was supported by NSERC Postdoctoral Fellowship. RBG was supported by a University Research Chair at the University of Ottawa. All other authors report no specific funding for this work. VCHC, MPM, and RBG own shares and/or options in Celestra Health Systems.

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