

Physiologic Responses and Changes in Walking Performance during the Six Minute Walk Test in People with Multiple Sclerosis: A Systematic Review

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Objective

- To determine physiologic responses and changes in walking performance in people with MS during the 6MWT.

Background

- Physical performance frequently declines in response to prolonged activities in people with MS.
- This decline may be associated with MS-related fatigability resulting in an elevated physiologic stress from altered gait patterns.
- Limited evidence exists to support this theory; however, these changes may potentially be captured during functional exercise tests such as the 6MWT.
- An understanding of MS-related changes in walking performance and their associated physiologic responses may help identify contributing factors to impaired physical performance during prolonged activities.
- This knowledge may guide future research and intervention strategies in the clinic.

Methods

- The SCOPUS, CINAHL and Medline databases were searched in July 2015 using the terms "six minute walk test AND Multiple Sclerosis".
- Studies that measured walking performance and/or physiologic responses during the 6MWT in people with MS were included.
- Validity of each study was assessed by two reviewers using the Critical Appraisal Skills Programme's (Oxford, UK) Cohort Study Checklist (CSC) which provides a score ranging from 0 (low validity) to 9 (high validity).

Table 1. Physiologic Responses and Changes in Walking Performance During the 6MWT

| Author & Year | Participant Characteristics | Physiologic Responses/Walking Changes |
|-----------------------|--|--|
| Burschka et al., 2012 | N=37 people with MS Disease severity: EDSS median: Mild (2, range 0-3.5), Moderate (4, range 4-5) Mean age in years: 39.7 +/- 12.8 Sex: 28 women/9 men Phenotype: RR (n=26), SP (n=8), CIS (n=3) Mean disease duration in years: RR (6.4 +/- 7.8), SP (6.4 +/- 5.6) | - Moderate MS group had earlier declines in WV as compared to the mild MS group. - Mild MS group did not slow significantly during the 6MWT, but did show changes in WV during the 12MWT. - Normal minute-by-minute WV pattern is U-shaped. The WV pattern in people with MS was an attenuated U-shape. |
| Dalgas et al., 2014 | N=80 people with MS Disease severity: EDSS mean: 4.1 +/- 1.5 (range 1-6.5); Mild (range 1-2.5), moderate (range 3.0-4.0), severe (range 4.5-6.5) Mean age in years: 50 +/- 9 Sex: 48 women/32 men Phenotype: RR (n=38), SP (n=27), PP (n=15) Mean disease duration in years: 12 | - Moderate and severe groups had lower HR throughout the 6MWT than the mild group. - Mild group had a greater increase in HR throughout the 6MWT compared to the moderate and severe groups. - Distance walked was significantly lower in minutes 4-6 compared to minute 1 in all severity groups |
| Leone et al., 2015 | N=208 people with MS Disease severity: EDSS mean: 4.2 +/- 3.6 Mean age in years: 47.9 Sex: 233 women/86 men Phenotype: RR (n=90), SP (n=82), PP (n=36) Mean disease duration in years: 11.3 | - Distance Walked Index (DWI) was calculated as the difference in distance walked in the 1 st and 6 th minutes of the 6MWT. - 55.2% has a decline in DWI of greater than 5% - 33.6% had no change (+/- 5%) in DWI - 7.7% has an increase (>5%) in DWI - Prevalence of a decline in DWI was higher in those with greater of disease severity, and in those with PP and SP phenotypes. |
| Motl et al., 2012 | N=95 people with MS Disease severity: EDSS mean: 4.5 (range 2.0-6.5); Mild n= 29 (EDSS=2-3.5); Moderate n= 29 (EDSS=4.0-5.5); Severe n=37 (EDSS=6.0-6.5) Mean age in years: 52.8 +/- 11.1 Sex: 76 women/19 men Phenotype: RR (n=78), SP (n=8), PP (n=5) Mean disease duration in years: 11.9 +/- 10.0 | - No minute-to-minute differences in cadence. - VO ₂ consumption increased every 30 seconds over the first three minutes, then levelled off during the last three minutes. |
| Sandrock et al., 2014 | N=160 people with MS (square path group n=82, straight path n=78) Disease severity: PDSS median: square path = 3.0 (0-6), straight path = 3.0 (0-6) Mean age in years: square path = 50.3 +/- 9.7, straight path = 49.5 +/- 8.7 Sex: square path: 66 women/16 men; straight path: 60 women/18 men | - The 6-minute walk was conducted in two test conditions: a straight path and a square path - In both conditions, VO ₂ consumption rose steadily through the first 3 minutes, then levelled off during the last three minutes - Both VO ₂ and walking distance were greater in those without gait disability (PDSS 0-2) than those with gait disability (PDSS ≥3). - More energy was consumed during the straight line path condition compared to the square path condition |

Abbreviations

12MWT, 12-Minute Walk Test; 6MWT, 6-Minute Walk Test; CIS, clinically isolated syndrome; EDSS, Extended Disability Status Scale; HR, heart rate; PDSS, Patient-Determined Disease Steps; MS, multiple sclerosis; PP, primary progressive; RR, relapsing-remitting; SP, secondary progressive; VO₂, volume of oxygen consumption; WV, walking velocity.

References

- Burschka, J. M., Keune, P. M., Menge, U., Hofstad-van Oij, O., Oschmann, P., & Hoos, O. (2012). An exploration of impaired walking dynamics and fatigue in multiple sclerosis. *BMC Neurology*, 12(1), 1.
- Dalgas, U., Kjellhede, T., Gjøbel, D., Romberg, A., Santoyo, C., de Noordhout, B. M., ... Feys, P. (2014). Aerobic intensity and pacing pattern during the six-minute walk test in patients with multiple sclerosis. *Journal of Rehabilitation Medicine*, 46(1), 59-66.
- Leone, C., Severijns, D., Doležalová, V., Baert, I., Dalgas, U., Romberg, A., ... Maamägi, H. (2015). Prevalence of Walking-Related Motor Fatigue in Persons With Multiple Sclerosis Decline in Walking Distance Induced by the 6-Minute Walk Test. *Neurorehabilitation and Neural Repair*, 1545968315597070.
- Motl, R. W., Suh, Y., Balantrapu, S., Sandrock, B. M., Sosnoff, J. J., Pula, J., ... Fernhall, B. (2012). Evidence for the different physiological significance of the 6-and 2-minute walk tests in multiple sclerosis. *BMC Neurology*, 12(1), 6.
- Sandrock, B. M., Pilutti, L. A., Dlugonski, D., Learmonth, Y. C., Pula, J. H., & Motl, R. W. (2014). Comparing two conditions of administering the six-minute walk test in people with multiple sclerosis. *International Journal of MS Care*, 16(1), 48-54.

Results

- Five studies were included in this systematic review. The participant characteristics and relevant physiologic responses and changes in walking performance are summarized in Table 1.
- The samples included people with MS with EDSS scores of <6.5 or PDSS scores of ≤6.0.
- Each study received a score of 8/9 on the CSC.
- Three studies examined walking performance by measuring walking velocity (WV) or distance walked per minute. One study measured cadence.
- Two examined physiologic responses by measuring rate of oxygen consumption (VO₂), and one examined heart rate (HR).

Conclusions

- Consistent declines in WV were observed during the 6MWT in the studies reviewed.
- Where examined, a consistent increase in physiologic activity (i.e. VO₂ and HR) was observed during the first 3 minutes of the 6MWT followed by a stabilization for the remainder of the test.
- Collectively, these observations suggest a decline in WV may be associated with an increase physiologic demand.
- A plausible theory is that MS fatigability may contribute to inefficient gait patterns that elevate the metabolic cost of walking.
- This exaggerated demand may contribute to the decline in self-selected WV during the 6MWT observed in people with MS.
- Future research is warranted to examine the interaction between changes in physiologic function and measures of walking efficiency to determine the etiology of the observed decline in walking performance.
- This knowledge will aid the clinician in identifying impairments that are amenable to rehabilitation with targeted interventions.