

Validation of the 2-Minute Walk Test with the 6-Minute Walk Test and Other Functional Measures in Persons with Multiple Sclerosis

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Background: *Persons with multiple sclerosis (MS) commonly have difficulty walking. The 6-Minute Walk Test (6MWT) assesses functional capacity but may be considered burdensome for persons with MS, especially those with higher disability levels. The 2-Minute Walk Test (2MWT) may be an alternative measure to the 6MWT. The purpose of this study was to investigate the validity of the 2MWT in persons with MS.*

Methods: *Twenty-eight ambulatory persons with MS aged 18 to 64 years participated in this cross-sectional study. Participants completed five measures of walking performance (2MWT, 6MWT, usual and fast gait speed, and Timed Up and Go test) and two functional measures (Berg Balance Scale and five-times sit-to-stand test) during a testing session. Participants were classified into two subgroups based on Disease Steps scale classification.*

Results: *The 2MWT was significantly correlated with the 6MWT ($r = 0.947$), usual gait speed ($r = 0.920$), fast gait speed ($r = 0.942$), the Timed Up and Go test ($r = -0.911$), and other functional measures. The 2MWT explained 89% of the variance seen during the 6MWT. The distances completed on the 2MWT and 6MWT accurately distinguished the subgroups.*

Conclusions: *This study demonstrated good construct and discriminant validity of the 2MWT in persons with MS, providing an efficient and practical alternative to the 6MWT. Validation of the 2MWT with other functional measures further supports these findings. *Int J MS Care.* 2018;20:158-163.*

Persons with multiple sclerosis (MS) commonly have difficulty in walking, leading to restrictions in mobility and community participation.^{1,2} A variety of walking tests are available to measure related but different aspects of walking disability in persons with MS, such as fatigability, distance limitations, and functional capacity.³

The 6-Minute Walk Test (6MWT) is a common measure of walking fatigability that demonstrates good psychometric properties.^{4,5} It is a common outcome measure for persons with MS⁶ and others.⁷⁻⁹ Several investigators characterize the 6MWT as time-consuming for the clinician and exhausting for persons with MS and indicate that the 2-Minute Walk Test (2MWT) may be a practical replacement.^{5,9} Kieseier and Pozzilli³ also suggest that the 2MWT assesses walking fatigability and walking distance limitations, although it may be limited by a floor effect in persons with less disability.

The 2MWT demonstrates good reliability¹⁰⁻¹³ and validity^{10,14-17} for persons with different conditions, although the strength of the findings is somewhat population specific. In some groups, 2MWT results were significantly correlated with the 6MWT results.^{6,18,19}

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Performance on the 2MWT, similar to the 6MWT, was correlated with other measures of function.¹⁰⁻¹⁴

Previous work established a strong association between distance on the 2MWT and 6MWT in persons with MS where distance on the 2MWT adequately predicted 6MWT distance.⁵ Gijbels et al.¹⁵ investigated the predictive ability of the 2MWT to determine habitual walking performance in persons with MS and found a positive association, especially for those with moderate activity limitations.

A number of authors^{3,6,9,16} recommend further investigation of the utility of the 2MWT as a possible substitute for the 6MWT in persons with MS given the decreased burden to both clinician and individual. Therefore, this study further investigated the validity of the 2MWT as a useful clinical measure for persons with MS by examining its relationship to other commonly used functional measures and its discriminant validity.

Methods

Participants

This is a cross-sectional analysis of baseline data from persons with MS in a falls prevention study. The inclusion criteria were as follows: adults with MS who are balance impaired, aged 18 to 64 years, at risk of falling (as determined by one or more of the following: more than one fall of unknown origin in the past 6 months, self-reported fear of falling, self-reported balance impairment), ability to ambulate 50 ft independently or with unilateral assistance, and medical clearance. The exclusion criteria were resting vital signs outside of established parameters to participate in an exercise program; unstable angina or myocardial infarction during the previous month; other than MS, any known neurologic or musculoskeletal diagnosis that would prevent participation in the falls-prevention program; participation in another research study; and insufficient language skills to participate in testing. Participants were classified into two subgroups using the Disease Steps scale.²⁰ One group exhibited mild disease consistent with Disease Steps scale categories 1 and 2 and walked without an assistive device. The second subgroup (Disease Steps scale categories 3 and 4) required a unilateral assistive device when walking more than 25 ft. The Disease Steps scale was developed as an alternative to the Kurtzke Expanded Disability Status Scale. Interrater reliability has been established ($\kappa = 0.80$).²⁰

Procedure

The study was approved by the institutional review board of the Office of Human Research of The George Washington University (Washington, DC). After informed consent was provided, measurements were taken during a single session lasting approximately 2 hours. Eligible participants were randomly assigned to begin testing with either the 2MWT or 6MWT. The other walk test was administered at the end of the session. The Berg Balance Scale (BBS), Timed Up and Go (TUG) test, usual and fast walking speed, and five-times sit-to-stand test (FTSST) were obtained in a consistent order after the initial walk test. The investigators (all the authors) were physical therapists with 4 to 31 years of experience who adhered to the study protocol procedures. Participants used their usual assistive device during the walk tests.

Measures

2MWT and 6MWT

American Thoracic Society (ATS) standardized procedures and instructions were used to administer the 2MWT and 6MWT^{21,22} except the course length was 50 ft. A physical therapist guarded each participant from behind; the pace was set by the participant. Blood pressure, heart rate, oxygen saturation, and rating of perceived exertion (Borg Scale) were recorded at baseline and completion. Participants were seated for 5 to 15 minutes before each walk test.

Gait Speed

Usual gait speed was measured using motion analysis software (PKMAS; ProtoKinetics LLC, Havertown, PA) performed on the 16 × 4-ft Zeno walkway (ZenoMetrics LLC, Peekskill, NY). There was a 5-ft acceleration and deceleration zone for each pass; participants performed two passes in response to “walk at your usual pace.” The test was repeated with instructions to “walk as fast as you safely can” to determine fast gait speed.

TUG Test

The TUG test time was measured using motion analysis software (PKMAS) performed on the Zeno walkway. Participants stood up from a chair, walked 3 m around a cone, walked back, and sat down in the chair “as fast as you safely can.”²³

Berg Balance Scale

The BBS consists of 14 items scored on a scale from 0 to 4 for a maximum score of 56.²⁴ Each item was completed under the direction of a physical therapist.

Five-Times Sit-to-Stand Test

Participants stood up and sat down from a standard chair five times as quickly as possible. They were encouraged to begin the test with their arms across their chest. This was done to minimize use of the arms for pushing; however, participants were not excluded if they used their arms. Time was recorded from when the investigator said “go” until the buttocks touched the chair after the fifth repetition.²⁵

Data Analysis

All the data were analyzed using IBM SPSS Statistics for Windows, version 23.0 (IBM Corp, Armonk, NY). Descriptive data are reported using means (SDs). Independent *t* tests compared mean walk test distances between those who performed the 6MWT first versus last. A significance level of $P < .05$ was selected.

Pearson product-moment correlation coefficients (*r*) were used to determine the relationship between 2MWT and 6MWT and the other functional measures. Univariate linear regression was performed to determine whether distance walked on the 2MWT predicted the 6MWT distance.

Independent *t* tests were used to compare the subgroup walking test performances. Logistic regression analyses were used to determine whether walk tests accurately discriminated between the subgroups.

Results

Participant Characteristics

Twenty-eight persons with MS participated in this study and completed all the measurements. The sample consisted mostly of women ($n = 21$ [75%]) and those with relapsing-remitting MS ($n = 22$ [79%]) (Table 1). All the participants completed the 2MWT without a rest; seven persons with MS used at least one rest during the 6MWT. Two participants required one instance of contact guarding to prevent a fall during the 2MWT, and four required contact guarding during the 6MWT. No adverse responses were noted.

All the data were distributed normally. There was no significant difference in the walk test distance between those who performed the 6MWT at the beginning of

Table 1. Descriptive characteristics and performance on the gait and functional measures in the 28 study patients

Variable	Value
Age, y	51.0 ± 8.7
Sex	
Male	7 (25)
Female	21 (75)
Height, in	65.4 ± 3.8
Weight, lb	167.9 ± 42.4
Multiple sclerosis type	
Relapsing-remitting	22 (78.6)
Secondary progressive	3 (10.7)
Unknown	3 (10.7)
Time since diagnosis, y	14.8 ± 13.4
Used assistive device during walk tests	12 (42.9)
2-Minute Walk Test, m	115.7 ± 46.1
6-Minute Walk Test, m	305.1 ± 137.1
Usual gait speed, m/s	1.00 ± 0.35
Fast gait speed, m/s	1.28 ± 0.45
Timed Up and Go test, s	13.5 ± 5.6
Berg Balance Scale score (maximum = 56)	41.4 ± 12.2
Five-times sit-to-stand test, s	16.1 ± 5.9

Note: Data are presented as mean ± SD or number (percentage).

the session and those who did so at the end; therefore, testing order was not considered.

Correlations

The 2MWT distance, the 6MWT distance, usual gait speed, fast gait speed, and TUG test time were strongly correlated (Table 2). The magnitude of the correlations for the 2MWT and the 6MWT with the other gait measures was similar. The mean (SD) gait speeds, 0.96 (0.38) m/s and 0.85 (0.38) m/s during the 2MWT and 6MWT, respectively, were comparable with usual gait speed (1.00 [0.35] m/s).

Table 3 presents the correlations among the 2MWT, the 6MWT, the BBS, and the FTSST. These associations were all significant at $P < .01$, although not as strong as the associations between the walk tests and the other gait measures. The magnitude of the associations of the 2MWT to the other gait and functional measures was similar to the magnitude of the 6MWT to the same measures.

Linear Regression Analysis

The 2MWT distances explained a large percentage of the variance in the 6MWT distance ($R^2 = 0.897$). The regression equation, $6MWT = -20.898 + 2.816(2MWT)$, predicts the 6MWT performance based on the 2MWT. The mean (SD) residual error com-

Table 2. Pearson product-moment correlations: walk test distances and other gait measures

	2MWT	6MWT	Usual gait speed	Fast gait speed	TUG test
2MWT	–	0.947 ^a (0.887 to 0.975)	0.920 ^a (0.833 to 0.963)	0.942 ^a (0.877 to 0.973)	–0.911 ^a (–0.958 to –0.815)
6MWT		–	0.969 ^a (0.933 to 0.986)	0.931 ^a (0.855 to 0.968)	–0.922 ^a (–0.964 to –0.837)
Usual gait speed			–	0.963 ^a (0.921 to 0.983)	–0.908 ^a (–0.957 to –0.809)
Fast gait speed				–	–0.935 ^a (–0.970 to –0.863)
TUG test					–

Note: Values in parentheses are 95% CIs.

Abbreviations: 2MWT, 2-Minute Walk Test; 6MWT, 6-Minute Walk Test; TUG, Timed Up and Go.

^a $P < .01$.

Table 3. Pearson product-moment correlations: walk test distances and other functional measures

	2MWT	6MWT	BBS	FTSST
2MWT	–	0.947 ^a (0.887 to 0.975)	0.753 ^a (0.528 to 0.879)	–0.652 ^a (–0.825 to –0.369)
6MWT		–	0.756 ^a (0.533 to 0.881)	–0.639 ^a (–0.817 to –0.349)
BBS			–	–0.558 ^a (–0.771 to –0.234)
FTSST				–

Note: Values in parentheses are 95% CIs.

Abbreviations: 2MWT, 2-Minute Walk Test; 6MWT, 6-Minute Walk Test; BBS, Berg Balance Scale; FTSST, five-times sit-to-stand test.

^a $P < .01$.

paring the predicted distance with the actual 6MWT distance is 29.2 (31.0) m (range, 1–116 m). This corresponds to a mean (SD) relative error of 11.1% (13.1%) (range, 0.7%–41.4%).

Subgroup Comparisons

The higher-functioning group walked almost twice as far as the lower-functioning group during the 2MWT and 6MWT (Table 4). The difference in the distance walked during both walk tests was statistically significant between the two groups, as were the other measures. For each subgroup, the 2MWT and 6MWT remained strongly correlated to each other ($r = 0.85$ and $r = 0.94$ for the higher- and lower-functioning groups, respective-

ly, $P < .05$). Logistic regression analyses demonstrated good ability to discriminate between the two subgroups. Using the 2MWT logistic regression equation cutoff point of 102.9 m, 82.1% of the sample was classified appropriately based on Disease Steps scale classification. In a similar manner, a 6MWT cutoff point of 265.3 m correctly classified 82.1% of the sample into the appropriate subgroup.

Discussion

The strong association between 2MWT performance and the other gait measures provides further support for its use with persons with MS. This finding is similar to the results of Gijbels et al.⁵; however, this study found a more consistent relationship between the two tests in persons with both mild and more severe limitations. This difference may be attributed to the modified ATS instructions used by Gijbels et al.,⁵ which emphasized walking speed and eliminated rest periods and verbal encouragement. Results obtained using modified ATS instructions may better reflect capacity or motor fatigue rather than habitual walking performance. Falls and sensory and motor symptom increases have also been reported using the modified instructions.⁴ Traditional ATS guidelines may better reflect habitual walking performance regardless of disability level.

The 2MWT was also significantly associated with other gait measures. The average error of 29 m for the predicted 6MWT distance from the linear regression

Table 4. Performance on gait and activity measures by higher- and lower-functioning persons with multiple sclerosis

Variable	Disease Steps scale categories	
	1 and 2 (n = 16)	3 and 4 (n = 12)
2-Minute Walk Test, m ^a	140.2 ± 40.2	83.2 ± 31.5
6-Minute Walk Test, m ^a	381.3 ± 120.5	203.4 ± 81.4
Usual gait speed, m/s ^a	1.19 ± 0.31	0.73 ± 0.19
Fast gait speed, m/s ^a	1.55 ± 0.35	0.92 ± 0.26
Timed Up and Go test, s ^a	10.4 ± 3.8	17.8 ± 4.8
Berg Balance Scale score (maximum = 56) ^a	49.5 ± 6.6	30.5 ± 9.1
Five times sit-to-stand test, s ^a	13.2 ± 5.4	23.2 ± 11.6

Note: Data are presented as mean ± SD.

^aSignificant difference between groups at $P < .05$.

equation was less than the reported minimal detectable change (88 m) in persons with MS.²⁶ However, comparisons between studies should be made with caution because varying disability levels are reflected in each sample.

The 2MWT may represent a more consistent measure of uninterrupted walking activity or habitual walking performance compared with the 6MWT. All the participants completed the 2MWT without a rest versus 25% requiring a rest during the 6MWT. Participants also required less balance assistance when performing the 2MWT versus the 6MWT. This finding is consistent with that of Karpatkin et al.,²⁷ who reported better performance on three successive 2MWTs versus one 6MWT. Neven et al.²⁸ found that persons with MS rarely walk for 6 continuous minutes. These findings support the potential of the 2MWT as a useful continuous measure of functional walking capacity for many persons with MS; however, if overall capacity or motor fatigue is the outcome of interest, the 6MWT with the modified ATS instructions may be a more appropriate measure.

Walk tests results are also strongly correlated with other measures of mobility.^{3,7,29-31} Based on this investigation, measures of balance (BBS) and functional strength (FTSST) were significantly related to both the 2MWT and the 6MWT. Again, the strength of the association between the walk tests and the other functional measures was similar for the 2MWT and 6MWT, providing further support for the construct validity of the 2MWT as an alternative measure to the 6MWT.

Comparison of the mean distances walked by subgroups stratified according to Disease Steps scale category demonstrated that the 2MWT and 6MWT could effectively discriminate between performance levels. Persons with Disease Steps scale classification of 3 and

4 walked a shorter distance on the 2MWT and 6MWT than persons with a classification of 1 and 2. This finding provides additional support for the validity of this measure to assess walking ability and functional capacity in persons with MS.

This study has limitations, one of which is that the sample was one of convenience. The results of this study apply to persons with MS whose Disease Steps scale category is 1 to 4, excluding those with more severe walking disabilities (Disease Steps scale category of 5). Sensitivity to change was not addressed and is critical to measuring the potential impact of interventions on walking disability in persons with MS. Further study is required to determine the usefulness of the 2MWT in measuring change over time for persons with MS.

In conclusion, measures related to gait that reliably quantify functional capacity but are less burdensome to persons with MS and the clinician are important to support clinical and research decisions. This study demonstrated the construct validity of the 2MWT in persons with MS as a potentially effective alternative to the 6MWT. Its shorter distance and decreased time may allow clinicians and researchers to measure walking in a way that is person-centered, efficient, timely, and safe. In addition, the distance walked on the 2MWT can be used to discriminate between persons with MS of higher and lower function. □

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PRACTICE POINTS

- Ambulation measures are used to determine activity limitations, need for health services, and effectiveness of therapy and are important measures of function.
- The 2-Minute Walk Test is a reliable and valid measure of walking capacity in persons with MS and can serve as an efficient alternative to longer walk tests, which may be impractical in certain settings and may be burdensome for persons with MS owing to fatigue.

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