ORIGINAL ARTICLE

Two-Minute Walk Test Performance by Adults 18 to 85 Years: Normative Values, Reliability, and Responsiveness

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Abstract

Objectives: To provide (1) normative reference values for the 2-minute walk test (2MWT), (2) reference equations for the 2MWT, and (3) information on the reliability and responsiveness of the 2MWT across the adult lifespan.

Design: Cross-sectional study.

Setting: General community settings.

Participants: A population-based sample of adult participants (N=1137) contributed data to this study, which was part of the National Institutes of Health (NIH) Toolbox for the Assessment of Neurological and Behavioral Function Norming Project.

Interventions: Not applicable.

Main Outcome Measure: 2MWT.

Results: Overall, the distance participants walked ranged from 64.6 to 300.8m (mean, 180.9m). Men walked farther than did women (189.4m vs 176.0m; $t=6.8$; $df=1,135$; $P<.001$). Significant correlations were observed between the 2MWT and age ($r=-.41$), height ($r=.29$), weight ($r=-.16$), and body mass index ($r=-.32$). Age and body mass index were used in the linear regression modeling to predict the 2MWT distance ($R^2=.55-.56$). Test-retest reliability of the 2MWT as characterized by the intraclass correlation coefficient was .82 (95% confidence interval, .76-.87). Based on a standard error of measurement of 15.3m, the minimum detectable change for the 2MWT was 42.5m.

Conclusions: The study presents norms of the 2MWT established by the NIH Toolbox. The norms can be used to determine the presence of limitations in walking endurance across the lifespan.

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Tests documenting the distance walked over extended periods of time (1−12min) are widely used to characterize functional endurance in research and clinical practice settings. Originally directed at patients with cardiovascular or pulmonary problems,[1,2] the tests have since been more broadly applied.[3-6] In 2002, the American Thoracic Society specifically recommended the 6-minute walk test (6MWT) and provided instructions for its performance.[7] Normative reference values[8-11] and information on the reliability[10,12,13] and responsiveness[14] of the 6MWT are abundant. Notwithstanding the American Thoracic Society's recommendation and the availability of such information, the time required to conduct the 6MWT can be an impediment to its use in some settings.

The distance that can be walked over 2 minutes represents a practicable alternative. Because the distance covered during a 2-minute walk test (2MWT) has been shown to correlate highly with that covered during a 6MWT,[1,3,15] it should not be surprising that the 2MWT has been used increasingly over the past decade.[15-25] Despite escalating use, normative reference values for the 2MWT have only recently become available, and those values are

from a relatively small sample of Brazilian adults (N=390 healthy participants).[21] Moreover, there is limited information on the test-retest reliability (individuals with stroke,[3,17] healthy adults in Brazil,[21] poliomyelitis,[22,26] neurologic impairment[27]) and responsiveness[17] of the 2MWT. If the 2MWT is to be advocated as an alternative to the 6MWT, additional reference values and information on the reliability and responsiveness of the test are needed.

The objective of this study was 3-fold. Specifically, we sought to provide (1) normative reference values for the 2MWT, (2) reference equations for the 2MWT, and (3) information on the reliability and responsiveness of the 2MWT across the adult lifespan.

Methods

The data for this investigation were collected from the Motor Domain of the National Institutes of Health (NIH) Toolbox for the Assessment of Neurological and Behavioral Function.[28] The intent of the NIH Toolbox is to develop an assessment battery that provides a standard set of royalty-free, brief, and comprehensive assessment tools that can be used by researchers and clinicians in various settings, with a particular emphasis on measuring outcomes in longitudinal epidemiological and prevention or intervention clinical research across the lifespan. Specifically used in this study were data from the norming phase of the project.[29] The project was approved by the Institutional Review Board of the Northwestern University, Chicago, IL, and all participants provided written informed consent.

Participants

A population-based sample of participants from 10 geographically diverse sites in the continental United States participated. To be eligible, individuals had to be community dwelling and noninstitutionalized, capable of following test instructions (English or Spanish), and at least 18 years old (a pediatric cohort was also collected and will be described in the future).

Note that participants took the 2MWT as part of the entire NIH Toolbox battery under the Motor Domain. Detailed norming plans for the NIH Toolbox have been described.[29] Briefly, the recruiting process included poststratification adjustment calculated using iterative proportional fitting, and so the weighted sample would have the same distribution on key demographic variables (age, sex, and language preference) as the United States population described in the 2010 Census. The order of administration of the tasks was randomized by blocking (cognitive, motor, emotion, sensory domain). Within each domain, tests were presented in a fixed order.[29]

For this study, individuals were excluded if they did not complete the 2MWT, lacked height or weight documentation, or were determined to be outliers on the basis of extreme 2MWT

distances (ie, >2.5SDs from the mean for their age category). For details, see figure 1.

Procedure

Basic demographic characteristics (sex, age, height, and weight) were determined for participants before any performance-based assessments were undertaken. Thereafter, a series of motor assessments were conducted, including the 2MWT. The 2MWT was performed over a 50-ft (15.2-m) out-and-back course. Participants were instructed to walk as fast as they could until asked to stop. They were also told not to worry if they had to slow down or rest, but that if they stopped they should start walking again as soon as they felt ready to do so. When 1 minute had elapsed, they were told "You are doing well; you have 1 minute left." Participants stopped walking at 2 minutes, and the distance covered was documented. Because the NIH Toolbox norming plan was designed to obtain the test-retest reliability coefficient for each test being validated, a subset of 157 participants repeated the 2MWT 4 to 21 days later (mean, 8.6d).

Analysis

The determination of normative values began with an exploratory examination of factors identified by previous researchers to be determinants of performance on the 6MWT, that is, sex, age, height, weight, and body mass index (BMI).[8,30,31]

First, descriptive statistical analyses were performed using the entire sample and by sex. Second, to compare the effect of sex and age group on the 2MWT performance, we performed a multifactorial (sex×age group) analysis of variance, followed by Scheffe post hoc statistics. Third, to obtain the predicting equation, we used a forward stepwise multiple regression analysis. The dependent variable was the 2MWT performance (continuous
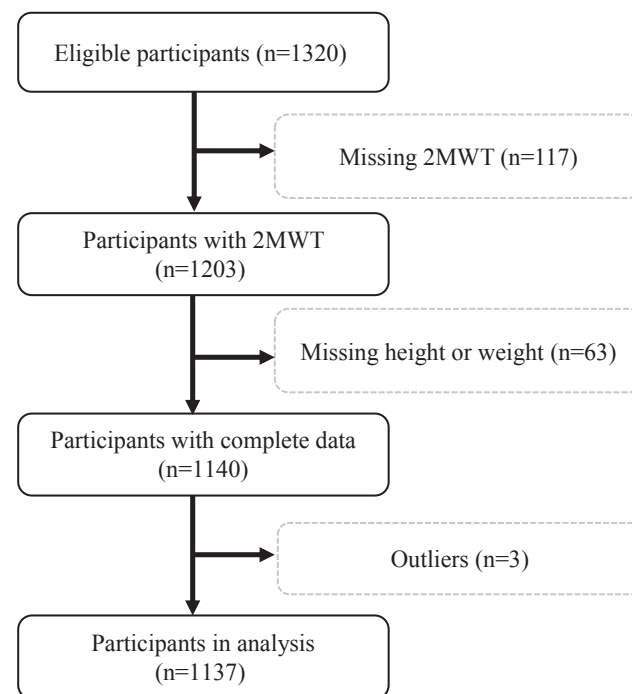

List of abbreviations:

2MWT	2-minute walk test
6MWT	6-minute walk test
BMI	body mass index
CI	confidence interval
ICC	intraclass correlation coefficient
MDC$_{95}$	minimum detectable change
NIH	National Institutes of Health

Fig 1 Data cleaning flowchart.

Eligible participants (n=1320)

Missing 2MWT (n=117)

Participants with 2MWT (n=1203)

Missing height or weight (n=63)

Participants with complete data (n=1140)

Outliers (n=3)

Participants in analysis (n=1137)