

The 2-min walk test could replace the 6-min walk test in ambulant persons with subacute or chronic stroke: a two-stage retrospective study

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The 6-minute walk test (6MWT) is widely used to assess walking capacity among persons with stroke. Whether a shorter and more convenient test, the 2-minute walk test (2MWT) could replace it, was tested. Two retrospective analyses were conducted. The first one was performed on a sample of 20 persons with stroke who performed both the 2MWT and the 6MWT, and the second one, on a group of 82 persons with stroke who performed the 6MWT while measuring the distance covered each minute. Linear regression models were applied to test the validity of 2MWT with regard to 6MWT. In the first group, distances covered during the 2MWT were highly predictive of the distances covered during the 6MWT (estimated adjusted $R^2=0.98$; $P<0.001$). In the second group, distances covered by participants during the first 2 min of the 6MWT were highly and linearly related to the distances they covered during the whole 6MWT (estimated adjusted $R^2=0.98$; $P<0.001$). Furthermore, the distance covered during the first 2 min of the whole 6MWT allowed us to

predict 98% of the variance of the 6MWT. Given its good metric properties and its practical advantages, clinicians and researchers could reasonably use the 2MWT when assessing the walking capacity of persons with stroke, instead of the 6MWT. *International Journal of Rehabilitation Research XXX: XXXX–XXXX* Copyright © 2022 Wolters Kluwer Health, Inc. All rights reserved.

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Introduction

Being able to walk is a critical determinant of function among persons with stroke. The recovery of walking capacity is therefore one of the main aims of the rehabilitation of persons with stroke [1]. It is paramount to validly measure walking among these persons.

Since the 1960s, when it was originally developed to assess the cardiorespiratory capacity of persons with heart pathologies, the 6-minute walk test (6MWT) has become increasingly used to assess walking-related performance (walking capacity, walking speed and walking endurance) of persons with various disorders [2]. Currently, besides the 10-meter walk test, Timed Up-and-Go and Berg Balance Scale, 6MWT is recommended to assess the walking capacity of persons with chronic neurological conditions such as stroke [3]. The distance covered during the 6MWT is a strong predictor of walking activity and participation in persons with stroke: a distance below 205 m predicts at best home ambulation, a distance between 205 m and 288 m predicts limited community ambulation and a distance superior to 288 m predicts community ambulation [4].

Several authors suggested that the walk test could be further reduced from 6 to 2 min [5]. Both tests would

assess the same domains, while the 2-minute walk test (2MWT) would be more convenient for subjects and clinicians, especially for more disabled persons, and less time-costly. In a group of 330 healthy people aged from 3 to 85 years, Bohannon *et al.* showed that the distances covered during the first 2 min of the 6MWT (2'6MWT) and during the whole 6MWT were highly correlated [5]. Gijbels *et al.* assessed a convenience sample of 40 persons with chronic multiple sclerosis presenting with mild to severe walking troubles [median Expanded Disability Status Scale 3.5 (1.5–6.5)]. The distances they covered in 2'6MWT were highly correlated with 6MWT [6]. Reid *et al.* also found that the distances covered during 2MWT and during 6MWT were highly correlated among 86 persons with lower limb amputations (83 unilateral amputations whose levels range from Syme to transfemoral, and 3 bilateral transtibial amputations) [7]. Similarly, Chan *et al.* showed the same correlation between the 2MWT and 6MWT among 39 frail older adults with dementia [age 87.1 (6.2), MMSE 13.2 (5.5)] [8]. However, the nature of gait impairments varies across conditions, and metric properties of the tests have to be determined in populations of interest. Regarding persons with stroke, Kosak *et al.* are the only authors who compared three different walk test durations (2, 6 and 12 min) [9]. They instructed

18 persons with subacute stroke to walk at a comfortable speed on a 122 m rectangular hallway for 12 min. The distances covered during the first 2 min, the first 6 min and the whole 12 min were highly correlated with each other.

To date, the 2MWT has not been further validated among persons with stroke, and remains widely less used than the 6MWT.

The aim of the present research was thus to assess the concurrent validity of the 2MWT and investigate whether it could eventually replace the 6MWT to assess walking capacity among persons after stroke.

Our hypothesis was that the distances walked during the 2MWT and during the first 2 min of the 6MWT (2'6MWT) would be highly predictive of the distance covered during the 6MWT.

Methods

To test the 2MWT concurrent validity, two retrospective analyses were conducted after approval by the Saint-Luc-UCLouvain Ethics Committee. No informed consent was required.

The first analysis studied the correlation between the distance covered by persons with stroke during the 2MWT and the 6MWT. The medical records of persons with stroke treated in our Rehabilitation Department in 2020, a period when both tests were implemented in routine clinical practice, were reviewed, to include persons that were submitted to both the 6MWT and the 2MWT. Subjects were excluded if they presented other musculoskeletal or neurological disorders affecting walking capacity or cardiorespiratory disorders contraindicating the tests. Twenty persons who performed both tests were included (sample 1). Their demographic and clinical characteristics are presented in Table 1. The initial severity of the stroke was assessed using the National Institutes of Health Stroke Scale (NIHSS) [10]. Their neurological motor impairments were respectively assessed with the Rasch validated short form of the Fugl-Meyer motor scale (FM-M) [11], their cognitive impairment with the Montreal Cognitive Assessment (MoCA) [12], and their walking ability with the Functional Ambulation Category (FAC) [13]. Participants performed both the 2MWT and the 6MWT according to the American Thoracic Society (ATS) guidelines [14], except that a 1-meter-marked 20 m walkway was used due to space restrictions. Approximately half of the subjects started with the 2MWT, the other half started with the 6MWT. The distance walked each minute and the total distance walked were recorded with a 0.5 m precision. Heart rate (HR) was manually measured based on a 20-s period before and directly after the test. Theoretical maximal HR was estimated based on Tanaka's formula [theoretical maximal HR = $208 - 0.7 \times \text{age (in years)}$] [15]. Between the two walk tests, a rest period of at least 20 min was granted.

Table 1 Characteristics of the participants and descriptive statistics of the experimental variables

	Sample 1 20 persons	Sample 2 62 persons
Age, years	60 (12)	59 (11)
Women, n (%)	7 (35)	25 (40)
Time since stroke, weeks	24 (5–56)	127 (44–244)
Initial NIHSS	13 (7) ^a	9 (6) ^b
Used assistive device during walk tests, n (%)	8 (40%)	NA
Fugl-Meyer upper limb	74 (24)	81 (26)
Fugl-Meyer lower limb	88 (15)	86 (21)
MoCA	25 (19.5–27.5)	25 (23–26)
FAC	5 (4–5)	N.A.
2MWT, m	130 (45)	N.A.
6MWT, m	364 (127)	386 (134)
2'6MWT, m	125 (43)	132 (45)
Percentage of theoretical maximal heart rate after 6MWT	59 (11) ^c	58 (10)
Percentage of theoretical maximal heart rate after 2MWT	55 (10) ^c	N.A.

Data are presented as mean (SD) or median (interquartile range).

2MWT, 2-min walk test; 6MWT, 6-min walk test; 2'6MWT, first 2 min of the 6MWT; FAC, functional ambulation category; MoCA, Montreal cognitive assessment; NA, data not acquired; NIHSS: national institutes of health stroke scale.

^aOne missing data.

^b24 missing data.

^ct-test between 2MWT and 6MWT is statistically significant ($P < 0.001$).

The second analysis studied the correlation between the distance covered by persons with stroke during the 2'6MWT and the distance covered during the whole 6MWT. This analysis was performed on data collected among 82 persons with stroke composed of two samples: the 20 persons included in the first analysis (sample 1), and 62 persons who participated in a previous study about poststroke fatigue [16] (sample 2) to improve power and confidence of statistical analyses. Among an extensive functional assessment, these 62 subjects performed a 6MWT following the same recommended protocol described above.

Results

In sample 1, The 20 subjects achieved an average (SD) distance of 130 (45) meters on the 2MWT and 364 (127) meters on the 6MWT. A multiple linear regression ('backward' mode) was performed setting the 6MWT as the dependent variable, and NIHSS at admission, age, time since stroke, FM-M, FAC, MoCA and 2MWT as independent variables. This analysis demonstrated that the 2MWT alone explains 97.7% ($P < 0.001$) of the variance (Fig. 1). Among the other variables, age and MoCA were retained as explanatory factors ($P < 0.05$), but explained only 0.7% of the variance (Fig. 1). Therefore, age and MoCA can then be disregarded in the predictive model, and a simple linear regression was used to show the relationship between the 2MWT and the 6MWT, following this equation (estimated adjusted $R^2 = 0.98$; $P < 0.001$):

$$6\text{MWT} = 2.79 \times 2\text{MWT} + 1.56 \text{ m}$$

On average, subjects walked slightly faster [mean difference = 0.07 m.s^{-1} (95% CI, 0.04–0.10), paired t -test $P < 0.001$] during the 2MWT [1.08 (0.38) m.s^{-1}] than during the 6MWT [1.01 (0.35) m.s^{-1}].

The 82 subjects (sample 1+2) achieved an average distance of 381 (132) meters during the 6MWT and 130 (45) meters during the 2'6MWT. A multiple linear regression ('backward' mode) showed that the distances covered by participants during the 2'6MWT were highly and linearly related to the distances they covered during the whole 6MWT (estimated adjusted $R^2 = 0.98$, $P < 0.001$). The sex, NIHSS at admission, age, FM-M, MoCA and time since stroke did not significantly influence this relation. The distance covered during the first 2 min of the whole 6MWT allowed us to predict 98% of the variance of the 6MWT result, following this equation (Fig. 2):

$$6\text{MWT} = 2.95 \times 26\text{MWT} - 3.71 \text{ m}$$

On average, the 82 subjects walked slightly faster (3%, paired t -test $P < 0.001$) during 2'6MWT [1.09 (0.37) m.s^{-1}] than during the whole 6MWT [1.06 (0.37) m.s^{-1}]. The subset of 20 subjects who performed both the 2MWT and 6MWT walked slightly faster (4%, paired t -test $P < 0.001$) during the 2MWT [1.08 (0.38) m.s^{-1}] than during the 2'6MWT [1.04 (0.36) m.s^{-1}]. On average, they covered 5 (7.2) more meters during the 2MWT than during the 2'6MWT.

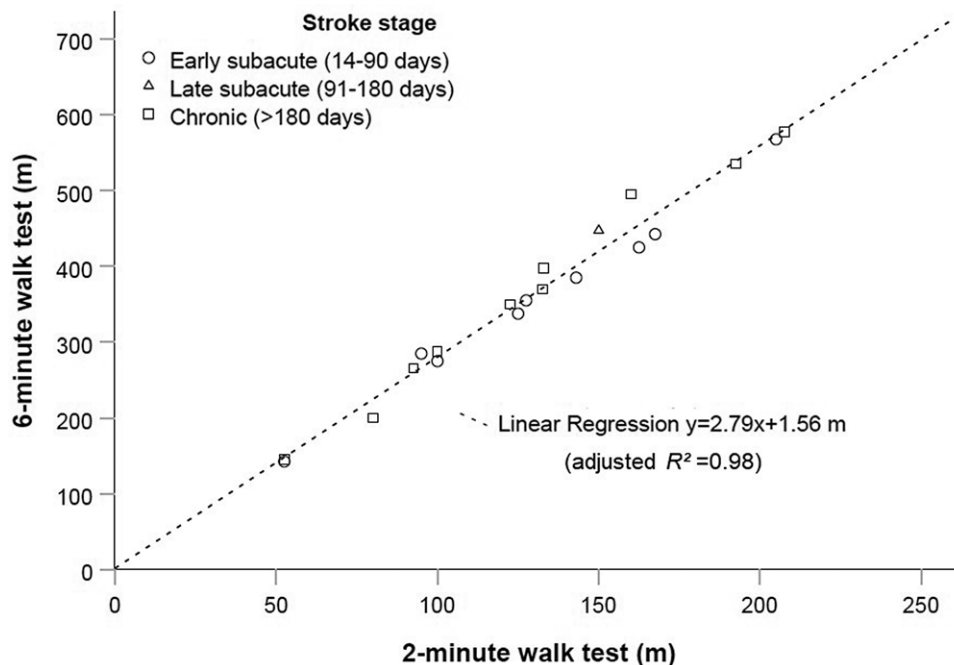
Discussion

This study shows that the 2MWT has an excellent concurrent validity with the 6MWT among included persons with stroke. Indeed, the distances covered during the 2MWT or the 2'6MWT predicted 98% of the variance of the 6MWT. Furthermore, other demographic and clinical parameters had either no or a marginal effect (i.e. age and cognitive functions) on the relationship between 2MWT and 6MWT, supporting the excellent concurrent validity of the 2MWT across the whole population of ambulatory persons with subacute and chronic stroke.

The slightly higher speed during the first 2 min of the 6MWT and the 2MWT, in comparison to the whole 6MWT, is systematic and linked to the pacing pattern [16], and is taken into account in the predictive equation.

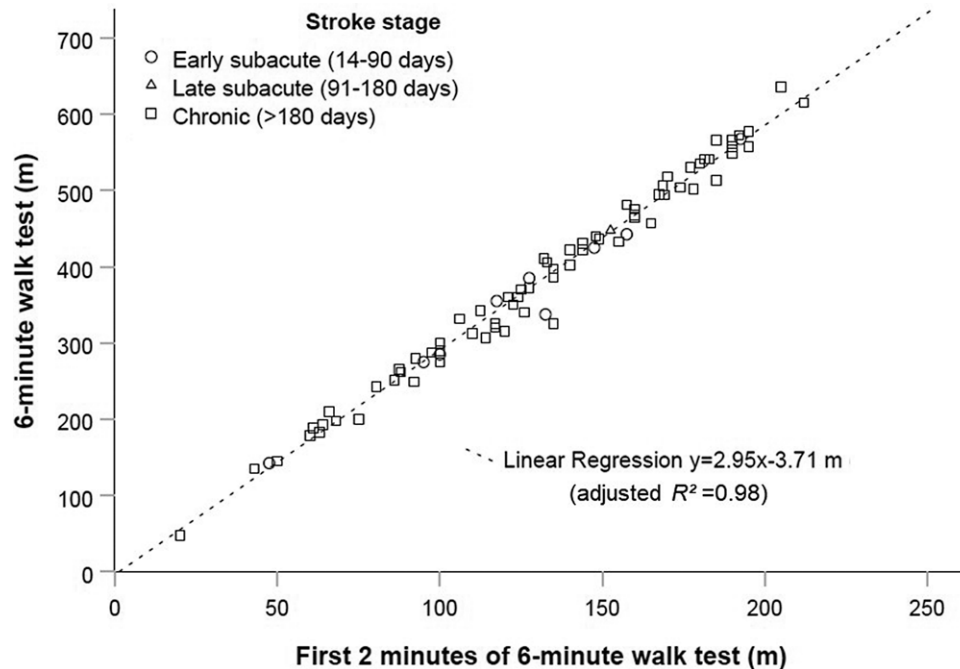
Importantly, and even if persons were instructed to walk 'as far as possible', the cardiorespiratory strain of the walk tests was limited, as reflected by the low mean percentage of theoretical maximal heart rate elicited (see Table 1). That further supports the fact that, among persons with stroke, 2MWT and 6MWT should strictly be used to assess walking (activity; d450 in the ICF), and not exercise tolerance (body function; b455), contrasting with persons with COPD or heart failure [17,18].

Fig. 1



Distance covered by each participant during the 6MWT presented as a function of the distance covered during the 2MWT, for the sample 1. Different symbols are used to illustrate the time since stroke. 2MWT, 2-min walk test; 6MWT, 6-min walk test.

Fig. 2



Distance covered by each participant during the 6MWT presented as a function of the distance predicted by the equation based on the distance covered during the first 2-minutes of the 6MWT, for both samples. Different symbols are used to illustrate the time since stroke. 6MWT, 6-min walk test.

To confidently implement the 2MWT in research and clinical practice, one should know its metric properties. Bohannon *et al.* studied the 2MWT among 1000 healthy subjects [19]. They showed that results depend on age, sex and BMI. Equations determining normative values were proposed.

They also showed good reliability of the 2MWT and estimated the minimal detectable change (MDC) to be 42.5 m for the 2MWT corresponding to 23.5% of the first measure. Among persons with stroke, Hiengkaew *et al.* showed an excellent test-retest reliability of the 2MWT and determined the MDC at 13 m for the 2MWT corresponding to 23% of the first measure [20]. The 2MWT's reliability was also excellent among persons with MS with an MDC of 20 m [21]. On the opposite, the minimal clinically important difference (MCID) of the 2MWT in stroke remains unknown. Taking into account the MCID of the 6MWT for stroke (34.4 m), the MCID of the 2MWT should be around 10 m [22]. Thus, the 5-m difference observed between the 2MWT and the 2'6MWT appears less important. Moreover, it is well known that healthy subjects and persons with stroke walk a little faster on shorter distances or during shorter duration tests [16].

The very high correlation between the 2MWT, 2'6MWT and the 6MWT is a strength of this work.

A few limits should be acknowledged. First, the retrospective design of the study precludes from randomizing the order of the 6MWT and 2MWT for sample 1. Second,

the 20 m walkway, instead of the recommended 30 m [14], induced an increase of turns that could reduce the total distance covered. But, as we used the same walkway for both the 2MWT and 6MWT, this should only marginally affect the relationship between these tests. Furthermore, in persons with COPD, the walkway length, if above 15 m, has no influence on the 6MWT [23]. Third, FAC was not specifiable for all the patients of sample 2; nevertheless, all the patients fell in categories 4 or 5. Finally, approximately one-third of participants were taking β -blockers, which partly limits the interpretability of HR-based data.

In conclusion, given its good metric properties obtained in the subjects included in our study and its practical advantages, clinicians and researchers could reasonably use the 2MWT to assess the walking capacity of ambulant persons with subacute or chronic stroke.

Acknowledgements

Conflicts of interest

Authors have no conflict of interest to disclose in relation this work.

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