



Original Article

Relationships between self-reported and performance-based measures of functional capacity in individuals with chronic stroke

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Abstract. [Purpose] The aim of this study was to investigate the associations between self-reported and valid performance-based measures of functional capacity in individuals with chronic stroke. [Subjects and Methods] Self-reported measures of functional capacity of 31 individuals with chronic stroke were assessed by the Duke Activity Status Index scores, whereas performance-based measures were assessed by the distance covered (in meters) and oxygen consumption (relative oxygen consumption, in $ml \cdot kg^{-1} \cdot min^{-1}$) during the six-minute walking test. [Results] The subjects had a mean age of 58.6 ± 13 years and a mean time since the onset of stroke of 28.3 ± 15.1 months. They had a mean Duke Activity Status Index of 27.3 ± 14.4 , mean distance covered of 325.2 ± 140.2 m, and mean relative oxygen consumption of 9.6 ± 2.3 $ml \cdot kg^{-1} \cdot min^{-1}$. Significant, positive, and moderate to good correlation coefficients were found between the Duke Activity Status Index scores and the distance covered during the six-minute walking test ($r=0.68$). Significant, positive, and fair associations were also found between the Duke Activity Status Index scores and relative oxygen consumption values obtained during the six-minute walking test ($r=0.45$). [Conclusion] The findings of the present study support the clinical use of the Duke Activity Status Index as a tool to assist in clinical evaluations of functional capacity of individuals with chronic stroke.

Key words: Stroke, Functional capacity, Rehabilitation

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INTRODUCTION

Assessment of functional capacity is important for identifying the physical implications of stroke, since it is currently considered the main cause of serious long-term disability in adults¹⁾, impairing physical, psychological, and social functions²⁾. After a stroke, individuals remain with several residual impairments, especially those related to motor function, which lead to reduced functional ability³⁾. In this sense, instruments that adequately capture several aspects of disability progression/regression are essential within clinical settings, implement more specific and effective disability management⁴⁾.

The use of functional tests is sometimes impossible during rehabilitation, due to the need for specialized equipment, expertise and space. In this sense, it is already known that aerobic capacity assessed on a treadmill, by analyzing the oxygen consumption (VO_2) is the gold standard measure of functional performance for disabled individuals⁵⁾. However, the widespread utilization of this method is limited by expertise, associated with the need for the use of specific and expensive equipment⁶⁾. On the other hand, an easy assessment, such as the six-minute walking test (6MWT), which is routinely used to assess functional walking capacity of stroke individuals^{4, 7, 8)} requires only a chronometer and a 30-meter corridor to be performed⁹⁻¹¹⁾. The establishment of valid and simple ways to use alternative measures of functional capacity after stroke would

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be, therefore, clinically relevant. The use of a simple tool for the assessment of functional capacity may allow clinicians to obtain clinically useful methods to estimate an important outcome, which can determine the degree of constraint imposed by the stroke, as well as its importance, by being a factor in diagnosis, prognosis, and a strong predictor of mortality¹².

An easily administered questionnaire was developed to assess functional capacity by the prediction of oxygen consumption (VO_2) without the need for maximal cardiopulmonary exercise testing¹³. The Duke Activity Status Index (DASI) is a short, simple questionnaire that can be administered to patients with physical limitations. It has been previously validated with physiological measurements, such as VO_2 in cardiac patients^{14, 15}. Although it was originally designed to evaluate patients with cardiovascular diseases, the DASI has also been shown to be valid and appropriate for the assessment of functional capacity of disabled individuals, such as those with moderate to severe chronic obstructive pulmonary disease (COPD)¹⁶. In order to allow for its clinical use in individuals with stroke, this study investigated the associations between the DASI scores and valid and extensively used functional capacity measures (distance covered and oxygen consumption obtained during the 6MWT).

Therefore, the specific research question for this study was: are there significant associations between the DASI scores and the distance covered and relative VO_2 during the 6MWT in individuals with chronic stroke?

SUBJECTS AND METHODS

Individuals with chronic stroke were recruited from the general community of the city of Belo Horizonte, Brazil, according to the following criteria: were ≥ 20 years old, had a mean time since the onset of a unilateral stroke between 1 and 5 years, were able to walk with or without assistive devices, and had no cognitive deficits, as determined by an education-adjusted cutoff score on the Mini-Mental State Examination: 18/19 for the individuals with illiteracy and 24/25 for individuals with a basic education¹⁷, and no other neurological or orthopedic disorders. This study was approved by the ethics review board of the Universidade Federal de Minas Gerais, and all participants provided written consent, prior to data collection.

Initially, the participants underwent a physical examination and an interview for the collection of clinical and demographic data, which included age, gender, body mass, height, time since stroke onset, number of medications, associated diseases, and habitual walking speed (10-meter walking test)^{18, 19}. At least 500 ml of water was provided prior to the tests, to guarantee normal hydration.

The DASI was applied by the same researcher to all participants. The questions were read loud and repeated if necessary, and none of the participants had difficulties in understanding them. Then, the participants performed the 6MWT without metabolic monitoring equipment, and the distance covered was recorded. The test was carried out in a 30-meter corridor according to the procedures and recommendations of the American Thoracic Society⁹, which were adapted to the Brazilian Portuguese language¹¹. Then, the individuals performed the 6MWT test with a portable metabolic system, which was previously calibrated. The means of the relative VO_2 ($\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$) values for the final three minutes of the 6MWT (steady state condition) were recorded for analyses²⁰.

The Brazilian version of the DASI was employed to assess the individuals' perceived functional capacity^{14, 16}. Its scores reflect the role of physiological factors in the individual's daily life and consider all important spheres related to functional capacity status, such as personal care, ambulation, household tasks, sexual function, and recreational activities²¹. It is composed of 12 items which describe daily living activities, with their correspondent metabolic equivalents (METs), and are answered with *yes* or *no*. The DASI scores ranged from 0 to 58.2, and higher scores reflect higher functional capacity^{14, 16}.

The distance covered during the 6MWT, which appropriately reflects functional capacity status, was recorded for analyses^{10, 22}. The 6MWT showed appropriate psychometric properties for individuals with stroke¹⁹.

The Cortex Metamax 3B is a portable metabolic system that allows online data transmission for a distance up to 800 meters. The measures are adjusted in real time, according to the environmental test conditions, by means of temperature and internal pressure sensors, and an electronic barometer. Its face mask has a low dead space volume and two inspiratory valves with low inspiratory resistance, and it allows the removal of exhaled air during testing, which leads to improved quality of the analyzed gases. The instrument has been shown to have adequate validity and reliability, when used in various activities with individuals with stroke²³ and to reflect the capture, transport and peripheral oxygen consumption.

Descriptive statistics and tests for normality (Shapiro-Wilk test) were carried out for all outcomes. Pearson correlation coefficients were calculated to explore the relationships between the DASI scores, distance covered, and the relative VO_2 during the 6MWT. The magnitudes of the correlations were classified as follows: low or none ($0.00 < r < 0.25$), fair ($0.25 < r < 0.50$), moderate to good ($0.50 < r < 0.75$), and good to excellent ($r > 0.75$)²⁴. All analyses were carried out with the SPSS software (release 17.0) with a significance level of 5%.

RESULTS

Thirty-one individuals participated in this study, including 17 men. They had a mean age of 58.6 ± 13 years, and a mean time since the onset of stroke ranging from 12 to 60 months. They had a mean DASI score of 27.3 ± 14.4 , a mean oxygen consumption of $9.6 \pm 2.3 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$, and a mean distance covered of 325.2 ± 140.2 m during the 6MWT. Their characteristics are described in Table 1.

Table 1. Characteristics of the participants

Characteristic	n=31
Age (years), mean (SD)	58.6 (13)
Gender, men, n (%)	17 (54.8)
Body mass index (kg/m ²), mean (SD)	25.7 (4.2)
Time since the onset of stroke (months), mean (SD)	28.3 (15.1)
Number of medications, mean (SD)	4.6 (2.1)
Associated diseases, mean (SD)	1.8 (.96)
MMSE (scores: 0–30), mean (SD)	25.6 (3)
Habitual walking speed (m/s), mean (SD)	0.8 (0.3)
DASI (scores: 0–58.2), mean (SD)	27.3 (14.4)
6MWT (distance, in meters), mean (SD)	325.2 (140.2)
Relative VO ₂ (ml.kg ⁻¹ .min ⁻¹), mean (SD)	9.6 (2.3)

SD: standard deviation; MMES: Mini-mental state examination; DASI: Duke Activity Status Index; 6MWT: 6-minute walking test; VO₂: oxygen consumption

Moderate to good correlation coefficients were found between the DASI scores and the distance covered during the 6MWT ($r=0.68$, $p<0.0001$). Significant and fair associations were also found between the DASI scores and the relative VO₂ obtained during the 6MWT ($r=0.45$, $p=0.03$).

DISCUSSION

To the best of our knowledge, this was the first study to use a brief and self-administered questionnaire to assess functional capacity in individuals with stroke, and the results answered the main question of this study. This study used a sample of ambulatory, individuals with chronic stroke with high functional levels, as demonstrated by their walking capacity and speed. Significant correlations were found between the DASI scores, the relative VO₂, and the distance covered during the 6MWT. In agreement with the findings of previous studies with other health conditions^{14, 25}, the DASI scores were significantly associated with both the physiological and physical performance measures. The results of the present study supported the use of the DASI as a tool to assist in clinical evaluations related to the functional capacity of individuals with chronic stroke.

Previous studies observed significant associations between the DASI scores and several outcomes in cardiac patients, such as metabolic equivalent^{26, 27}, New York Heart Association²⁸, Canadian Cardiovascular Society of angina²⁹, and body mass index²⁷. The associations between the DASI scores and the distance covered during the 6MWT were previously investigated in cardiac⁶ and in COPD patients¹⁶, and moderate to good correlations were found between the investigated variables ($r=0.68$; $p<0.001$ and $r=0.58$, $p<0.0001$, respectively). Additionally, Bagur et al.²⁸ also found moderate to good correlations between the DASI scores and the distance covered during the 6MWT in patients, who underwent transcatheter aortic valve implantation at baseline ($r=0.55$, $p<0.0001$) and at six-month follow-up ($r=0.66$, $p<0.0001$). These results are in line with the findings of the present study, which found correlation coefficients of similar magnitudes. These similarities could be explained by the fact that all studies had participants with chronic diseases and several disabilities. In addition, individuals with stroke have some cardiac dysfunctions as the main associated morbidity and risk factors for new episodes of stroke².

No previous studies were found that investigated the associations between relative VO₂ during the 6MWT and the DASI scores. Several studies found associations between the DASI scores and peak VO₂ during maximal tests on cycle and arm ergometers, as well on treadmills with various populations, such as patients with vascular diseases ($r=0.51$, $p<0.001$)¹⁴, COPD patients ($0.34<r<0.38$, $p<0.0001$)¹⁶, and cardiac patients ($0.58<r<0.81$, $p<0.0001$)¹³. In the present study, fair correlations between the relative VO₂ during the 6MWT and DASI scores were found. Regarding these findings, Jakovljevic et al.³⁰ pointed out that the ability of the skeletal muscles to extract oxygen is decreased after stroke, but their cardiac function and pumping capability were preserved. Additionally, it was found that individuals with stroke showed reduced blood flow, higher lactic acid production, and decreased capacity to oxidase free fatty acids by their paretic muscles³¹. These findings could partially explain the results of the present study, since fair correlations were found. However, it is well known that stroke individuals exhibit a constellation of impairments, as well as comorbidities, which were not investigated in the present study, and these could have influenced the results.

It is important to notice that this was the first study to analyze the associations between self-reported and direct measures of functional capacity and found associations of magnitudes ranging from fair to good. These results are in agreement with those of Teixeira-Salmela, Devaraj, and Olney³², who found good relationships between self-reported physical activity levels and observed performances of individuals with chronic stroke. Taking together, these findings reinforce the importance of taking the patients' perceptions into consideration during the rehabilitation process.

Due to the design of this study, causal relationships cannot be determined. The sample size was composed of individuals

at the chronic stages after stroke, who had a time since the onset of the stroke ranging from one to five years, were able to walk independently, and had good functional levels (mean walking speed of 0.81 m/s and mean distance covered during the 6MWT of 325 meters). In this sense, the results of the present study cannot be generalized to individuals with different functional levels and at the acute and subacute phases after stroke³³). Finally, other parameters related to functional capacity were not investigated. For instance, it is well known that the major motor deficit after stroke is weakness, which is found in 80% of stroke survivors. Thus, these aspects should be taken into consideration in future studies. It is important for health professionals to focus on the implications of a given health condition on an individual's life¹⁴). Thus, some instruments should be used based upon their impact on their real life contexts. The DASI has been demonstrated to be a useful tool for clinical and research purposes, since it provides insights regarding function that may not be captured by physiological measures^{14, 16}).

The results of the present study revealed positive, significant, and moderate to good associations between the DASI scores and the distance covered during the 6MWT and positive, significant, and fair correlations between the DASI scores and the relative VO₂ during the 6MWT. These findings support the utility and validity of a self-report measure in providing an indirect index of functional capacity.

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