

The Relationship between Clinical Measures and Daily Physical Activity and Participation in Ambulatory, Community-Dwelling People with Stroke

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Abstract

Objective: To examine the extent to which daily physical activity and social participation are associated with clinical measures of motor function, balance, balance self-efficacy, functional mobility, and walking speed and distance in community-dwelling people with stroke.

Methods: In a cross-sectional study, the Chedoke-McMaster stroke assessment (CMSA; leg and foot scales), Berg balance scale (BBS), activities-specific balance confidence (ABC) scale, timed 'up and go' (TUG), 5-meter walk test (5mWT), 6-minute walk test (6MWT), and the stroke impact scale (SIS; participation scale) were used to measure lower extremity motor function, balance, balance self-efficacy, functional mobility, walking speed and distance, and participation, respectively. Daily physical activity was estimated using time spent upright during standing and walking measured over a five-day period with a uniaxial accelerometer (activPAL).

Results: Fifteen men and two women participated. The mean \pm standard deviation age and time post-stroke were 71.4 ± 9.7 and 2.0 ± 0.1 years, respectively. Time spent upright per day was 192 ± 141 minutes and SIS participation scores were 68 ± 21 points. ABC scale ratings and comfortable gait speed correlated with physical activity ($\rho=0.66$ and 0.50 , $p=0.004$ and 0.043 , respectively) and participation ($\rho=0.62$ and 0.48 , $p=0.007$ and 0.049 , respectively). Time spent upright and participation scores were also correlated ($\rho=0.66$, $p=0.004$).

Conclusions: Balance self-efficacy and comfortable walking speed are moderately associated with time spent standing and walking per day as well as social participation in ambulatory, community-dwelling people with stroke. The ABC scale and the 5mWT are recommended as interpretable measures of outcome in stroke rehabilitation with relevance to community living.

Keywords: Stroke; Motor activity; Social participation; Movement; Postural balance; Self-efficacy; Walking

Introduction

Physical rehabilitation post-stroke aims to optimize balance; mobility and gait function so that people can be physically active and participate in meaningful activities [1,2]. Physical activity is important to maintaining health and reducing the risk of cardiovascular disease and recurrent stroke [3,4]. Self-report measures of physical activity, while simple and affordable, may overestimate levels determined on objective testing [5]. The use of accelerometers provides an alternative method to objectively quantify physical activity [6-8]. Participation encompasses physical activity as it denotes the involvement of individuals in activities, including relationships, community activities, work, recreation and leisure, that bring meaning to life [9].

Investigation of the relationship between physical rehabilitation outcomes and physical activity has been primarily restricted to motor, balance and walking capacity. For example, physical activity measured using an accelerometer has been found to correlate with scores on the Berg balance scale [10] (BBS) ($r=0.54-0.58$) [7,11], self-selected gait speed [12] ($r=0.55-0.65$) [6,7,11], and 6-minute walk test [13] (6MWT) performance ($r=0.67-0.73$) [6-8]. Examination of relationships between physical activity and motor function and broader outcomes such as social participation and health-related quality of life has been limited to one study of people with mild gait deficits post-stroke (mean self-selected gait speed 1.01 meters/second (m/s)) in which no correlations were observed [7]. In addition, although balance self-efficacy has been recognized as a predictor of self-reported physical function and perceived health status [14], its association with physical activity directly measured using accelerometry is unknown. Balance self-efficacy refers to perceptions of ability to perform everyday

activities without losing balance or becoming unsteady [15]. Self-efficacy is considered a modifiable outcome [16] that could be targeted through physical rehabilitation to influence physical activity and participation. Increasing understanding of the relative influence of physical rehabilitation outcomes on physical activity and participation can help to guide treatment planning, the selection of appropriate goals during rehabilitation after stroke, and inferences about potential to function in the community. Although predictors of participation have been previously investigated [17,18], the comparative influence of physical rehabilitation outcomes on both daily physical activity and participation has received little attention. Thus, the objective of this study was to examine the extent to which daily physical activity and social participation are associated with clinical measures of motor function, balance, balance self-efficacy, functional mobility, and walking speed and distance in community-dwelling people with stroke. Based on the literature, it was hypothesized that moderate-level (i.e., 0.50-0.69) correlations would be observed.

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Materials and Methods

Design

As part of a prospective cross-sectional study that also aimed to investigate cardio respiratory responses during tests of aerobic capacity post-stroke [19], a trained physiotherapist administered clinical and participation measures in two evaluation sessions that were separated by a minimum of 72 hours. During the first session, socio demographic data were collected and participation and clinical measures, with the exception of the 6MWT, were administered. The order of testing was the same for all participants. At the second session, participants completed two trials of the 6MWT and were given an accelerometer to measure physical activity. The hospital ethics board approved the research protocol and participants provided written, informed consent.

Participants and recruitment

Ambulatory individuals living in the community following a hemorrhagic or ischemic stroke were targeted. People were considered eligible if they had a clinical diagnosis of stroke recorded in the medical chart, were able to walk 10 meters (m) independently with or without an assistive device, had lived in the community at least 3 months post-stroke, and were able to follow three-step instructions. People were excluded if they had a resting blood pressure greater than 160/100 despite medication, comorbid conditions that would limit exercise tolerance (e.g. painful arthritis), and cognitive or behavioural issues that would preclude testing. Individuals who had been discharged from an inpatient rehabilitation program and were attending an outpatient clinic at a community rehabilitation hospital were screened for eligibility. Those meeting the eligibility criteria were invited to participate.

Characteristic	Mean \pm SD (Range)*
Age in years	71.4 \pm 9.7 (57-93)
Sex, No. (%)	
Men	15 (88)
Women	2 (12)
Body mass index (kg*m ⁻²)	26.1 \pm 4.0 (21.8-35.9)
Type of stroke, No. (%)	
Ischemic	9 (53)
Hemorrhagic	2 (12)
Missing	6 (36)
Side of hemiparesis, No. (%)	
Right	8 (47)
Left	8 (47)
Bilateral	1 (6)
Years post-stroke	2.0 \pm 0.1 (0.5-4.2)
National Institutes of Health Stroke Scale (/42)	3.2 \pm 2.5 (0-10)
Medications, No. (%)	
Beta-blockers	4 (23)
ACE inhibitors	6 (35)
Both	4 (23)
None	3 (18)
Walking aid used, No. (%)	
No aid	7 (41)
1-point cane	4 (23)
4-point cane	5 (29)
Rollator walker	1 (6)

*Results are presented as Mean \pm SD (Range) unless otherwise noted.

Table 1: Participant characteristics (n=17).

Measurement

The Chedoke-McMaster stroke assessment [20] (CMSA) leg and foot scales were used to determine motor function of the leg and foot, respectively. Balance, balance self-efficacy, functional mobility, comfortable gait speed, functional walking capacity, and participation were evaluated using the BBS, activities-specific balance confidence (ABC) scale [21], timed 'up and go' [22] (TUG), 5-meter walk test [12] (5mWT), 6MWT, and the participation scale of the stroke impact scale [23] (SIS), respectively. With the exception of the TUG, a higher score on all measures indicates a higher level of performance. Two 6MWT trials were performed according to established procedures [24] with a minimum 20-minute rest between trials. The best performance was analysed. The use of these measures is reliable and valid in people with stroke.

To estimate physical activity, participants were asked to wear a uniaxial accelerometer (activPAL™, PAL Technologies Ltd, Glasgow, United Kingdom) attached to the right thigh for five consecutive days during waking hours, except during showering. In older adults with impaired function, including 14 people with stroke, the activPAL™ has been shown to accurately estimate the time spent upright during standing and walking activities, but not step counts [25]. Thus, the number of minutes spent upright during standing and walking activities per day, averaged over the five days, was used in the current study to estimate daily physical activity.

Analysis

Due to the ordinal nature of the response scales for the majority of measures, the non-parametric Spearman correlation was used to estimate associations with a significance level of 0.05. A correlation coefficient of 0.90 to 1.00 was interpreted as very high, 0.70 to 0.89 as high, 0.50 to 0.69 as moderate and 0.26 to 0.49 as low [26]. Results were presented as mean \pm standard deviation unless otherwise indicated.

Results

Of the 23 individuals who consented to participate, 4 (17%) did not complete the study due to the occurrence of another stroke (n=1) and loss to follow up (n=3). One participant returned the activPAL™ with no data and one participant never returned the accelerometer. Thus, complete data from 17 individuals were analyzed. Fifteen men and two women participated. Age and time post-stroke were 71.4 \pm 9.7 and 2.0 \pm 0.1 years, respectively. Table 1 presents participant characteristics.

Participants wore the accelerometer an average of 12.1 hours/day over the five day period. One individual wore the accelerometer for three days and one person wore it for two days instead of five days. For one participant who used a motorized wheelchair, accelerometry output indicated that no time was spent upright over the five-day period. The time spent upright per day was 192 \pm 141 (Range 0-468) minutes. SIS participation scores were 68 \pm 21 (Range 31-100). Table 2 presents the scores on clinical measures and their correlation with time spent upright per day and SIS participation scores. ABC scale ratings and comfortable gait speed correlated with physical activity ($\rho=0.66$ and 0.50 , $p=0.004$ and 0.043 , respectively) and participation ($\rho=0.62$ and 0.48 , $p=0.007$ and 0.049 , respectively). Time spent upright correlated with participation scores ($\rho=0.66$, $p=0.004$).

Discussion

In ambulatory, community-dwelling individuals with stroke, scores on measures of balance self-efficacy and comfortable gait speed

Clinical Measure (range of score or unit)	Scores		Mean time spent upright per day		SIS participation scores	
	Mean ± SD	Range	rho	p-value	rho	p-value
CMSA Leg (1-7)	5.2 ± 1.1	3-6	0.34	0.182	0.32	0.214
CMSA Foot (1-7)	4.3 ± 1.6	2-7	0.27	0.286	0.16	0.534
BBS (0-56)	41.1 ± 11.9	12-55	0.22	0.399	0.11	0.680
ABC scale (0-100%)	58.6 ± 22.3	5.6-89.4	0.66	0.004	0.62	0.007
5mWT (m/s)	0.6 ± 0.5	0.1-2.0	0.50	0.043	0.48	0.049
6MWT (m)	240.3 ± 184.0	32.0-631.0	0.48	0.051	0.43	0.082
TUG (s)	34.6 ± 27.9	4.3-109.4	-0.24	0.358	-0.26	0.306

SD: standard deviation; SIS: stroke impact scale; CMSA: Chedoke-McMaster stroke assessment; BBS: Berg balance scale; ABC: activities-specific balance confidence; 5mWT: 5-meter walk test; 6MWT: 6-minute walk test; TUG: timed 'up and go'.

Table 2: Scores on clinical measures and correlation with physical activity and participation measures (n=17).

correlated moderately with physical activity estimated using daily time spent upright. A moderate correlation between balance self-efficacy and SIS participation scores and a low correlation between comfortable gait speed and SIS participation scores were observed. These associations suggest that as balance self-efficacy and walking speed improve, daily physical activity and participation after stroke also tend to improve. Results support the clinical relevance of using the ABC scale and the 5mWT to make inferences about an individual's expected physical activity and participation level on returning home.

The correlation between comfortable gait speed and physical activity in the current study was similar to values reported previously [6,7,11]. In contrast, the correlations between scores on the 6MWT and BBS and physical activity in the current study were substantially weaker than previous estimates [6-8,11] and non-significant. In four previous studies, [6-8,11] participants were younger and participants' walking ability was either better (two studies) or worse (one study) compared to individuals in the current study. Moreover, the time period over which the accelerometer was worn, the placement of the accelerometer (ankle vs. thigh), and the parameter used to estimate physical activity (step/activity counts vs. time spent upright) varied across studies making it difficult to compare results.

Of all the clinical measures, ratings of balance self-efficacy most strongly correlated with estimated daily physical activity and participation reinforcing the potential importance of targeting improvement in balance self-efficacy in stroke rehabilitation. According to self-efficacy theory [27], perceived ability to maintain balance in the performance of everyday tasks is expected to influence an individual's decision to perform those tasks

In addition to balance self-efficacy, estimates of physical activity also correlated moderately with ratings of participation. The SIS participation scale is used to evaluate the extent to which stroke has limited an individual's involvement in work, social activities, recreation, sports/outings/travel, relationships, spiritual activities, and ability to control one's life and to help others. In a previous study by Fulk et al. [7] of people with less severe balance and mobility deficits than observed in the current study, the number of steps taken per day did not correlate with social participation measured using the SIS (r=0.18). The greater variability in gait speed in the current study (0.6 ± 0.5 m/s) compared to the study by Fulk et al. (1.01 ± 0.31 m/s), may have enabled a relationship to be observed. One can postulate that the ability to maintain standing and walking activity

would enable participation in many of the activities captured by the SIS participation scale, including work, social activities, recreation, sports/outings/travel, and the ability to help others.

Finally, the weak correlation coefficients observed between scores on the majority of clinical measures and daily physical activity and participation suggests that other factors, such as mental health [17], the availability of a caregiver to facilitate outings, or the walkability of the community environment [28] may help explain physical activity and participation after stroke.

Limitations

The cross sectional design limits causal inferences about the associations observed. Findings apply primarily to men who can ambulate independently after stroke. The small sample size restricted the detection of statistically significant low correlations.

Conclusions

Balance self-efficacy and comfortable walking speed are moderately associated with time spent standing and walking per day as well as social participation in ambulatory, community-dwelling people with stroke. The ABC scale and measures of walking speed, such as the 5mWT, are recommended as interpretable measures of outcome in stroke rehabilitation with relevance to community living.

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Conflict of interest

The authors have no conflicts to disclose.

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