



BRIEF REPORT

Comparison of Self-Report Versus Sensor-Based Methods for Measuring the Amount of Upper Limb Activity Outside the Clinic

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Abstract

Objective: To compare self-reported with sensor-measured upper limb (UL) performance in daily life for individuals with chronic (≥ 6 mo) UL paresis poststroke.

Design: Secondary analysis of participants enrolled in a phase II randomized, parallel, dose-response UL movement trial. This analysis compared the accuracy and consistency between self-reported UL performance and sensor-measured UL performance at baseline and immediately post an 8-week intensive UL task-specific intervention.

Setting: Outpatient rehabilitation.

Participants: Community-dwelling individuals with chronic (≥ 6 mo) UL paresis poststroke (N=64).

Interventions: Not applicable.

Main Outcome Measures: Motor Activity Log amount of use scale and the sensor-derived use ratio from wrist-worn accelerometers.

Results: There was a high degree of variability between self-reported UL performance and the sensor-derived use ratio. Using sensor-based values as a reference, 3 distinct categories were identified: accurate reporters (reporting difference ± 0.1), overreporters (difference > 0.1), and underreporters (difference < -0.1). Five of 64 participants accurately self-reported UL performance at baseline and postintervention. Over half of participants (52%) switched categories from pre- to postintervention (eg, moved from underreporting preintervention to overreporting postintervention). For the consistent reporters, no participant characteristics were found to influence whether someone over- or underreported performance compared with sensor-based assessment.

Conclusions: Participants did not consistently or accurately self-report UL performance when compared with the sensor-derived use ratio. Although self-report and sensor-based assessments are moderately associated and appear similar conceptually, these results suggest self-reported UL performance is often not consistent with sensor-measured performance and the measures cannot be used interchangeably.

Archives of Physical Medicine and Rehabilitation 2018; ■: ■ ■ ■ ■ - ■ ■ ■ ■

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Individuals are referred for stroke rehabilitation services to improve performance in daily life. Performance, defined as what a person actually does in his/her current environment, outside of a clinic or laboratory,¹ is difficult to measure for the upper limb (UL). Performance is most commonly quantified by amount, with other aspects (eg, quality, efficiency) being more difficult to measure during everyday life. Researchers must choose between

self-report measures of UL performance, which provide critical information about patient perception of abilities but are subject to inherent biases (eg, social desirability, recall bias),^{2,3} or sensor-based methods (eg, accelerometry). Accelerometry is a valid, reliable, quantitative measure of UL performance in daily life^{4,5} and is not subject to the same biases as self-report measures, but cannot determine the specific activities someone performs and captures functional and nonfunctional movements.

A recent physical activity review indicates self-report and sensor quantifications of physical activity vary widely and unsystematically, with correlations ranging from -0.7 to 0.7 across studies.⁶ The purpose of this brief report was to compare

Presented to the Translational Science National Meeting, April 20, 2017, Washington, DC. Supported by the National Institutes of Health (grant nos. R01 HD068290 and TL1 TR002344).

Disclosures: none.

Table 1 Participant demographics (N=64)

Demographic	Value
Age	61.2±11.1
Sex, F/M	22/42
Race	37 white 26 black 1 multirace
Type of stroke	47 ischemic 6 hemorrhagic 11 unknown
Months poststroke, median (minimum–maximum)	11.5 (6–180)
Affected side, R/L	35/29
Concordance, %*	52
Independent with ADL, %	81
Baseline ARAT score [†]	32±10.9
Baseline use ratio	0.66±0.2
Baseline MAL AOU [‡]	2.73±0.9

NOTE. Values are mean ± SD, n, or as otherwise indicated. Abbreviations: ADL, activities of daily living; ARAT, Action Research Arm Test; F, female; L, left; M, male; R, right.

* Dominant side is paretic side; value indicates the percentage of the sample who identified their dominant UL as the paretic UL.

[†] Scores range from 0 to 57 points with higher scores indicating more normative movement. Here, participants had mild to moderate UL paresis at baseline.

[‡] Scores range from 0 to 5 (0=did not use the paretic UL; 5=used the paretic UL as often as before the stroke).

self-report and sensor-based measures of UL performance in daily life in a clinical trial cohort of persons with chronic stroke. Although these measures are moderately correlated,⁵ it is critical to know the accuracy and consistency between them.

Methods

This was a secondary analysis from a phase II, randomized, dose-response trial of intensive, task-specific UL motor training (see Lang et al⁷ for comprehensive assessment battery).⁷ Data from baseline and postintervention assessment time points were used here. The trial was approved by the Washington University Human Research Protection Office, and all participants provided informed consent.

Assessments

Our sensor-based measure of UL performance was derived from bilateral, wrist-worn accelerometers.^a Participants wore the accelerometers for 24 hours at baseline and again postintervention during all daily activities.⁸ The variable of interest for this comparison was the use ratio, an established metric of UL performance in daily life.^{4,9} The use ratio quantifies the amount of time the paretic UL is active relative to the nonparetic UL and ranges

List of abbreviations:

AOU	amount of use
CI	confidence interval
MAL	Motor Activity Log
UL	upper limb

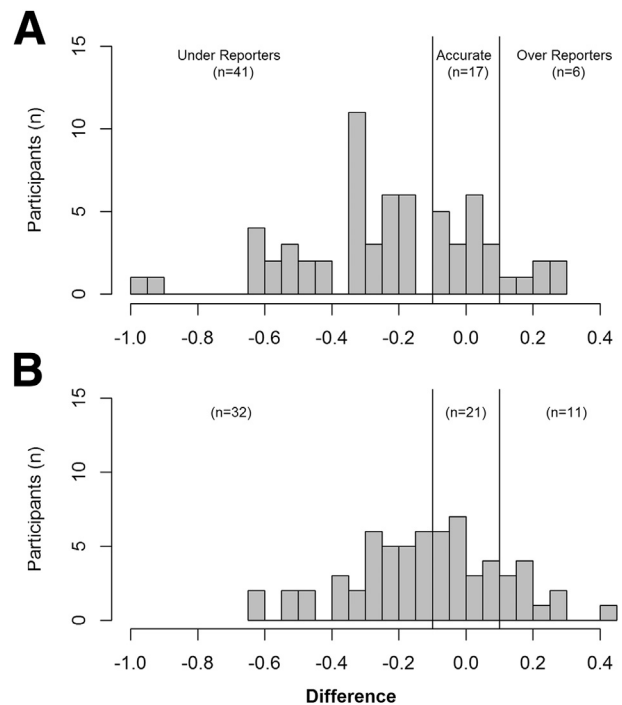


Fig 1 Reporting differences (MAL–use ratio) across the sample for (A) baseline and (B) postintervention. Accurate reporters were defined as a difference value of ± 0.1 , underreporters were < -0.1 , and overreporters were > 0.1 . There was a high degree of variability between self-reported and sensor-derived performance at both time points, with most participants underreporting. We did not control for weekday versus weekend wearing schedules for participants because previous work has shown that both days are similar in terms of functional demands for this population.

from 0 to 1. A use ratio value of 1 indicates both ULs were active the same amount of time throughout the recording period. Healthy, nondisabled adults have a use ratio value of $.95 \pm .06$.⁹

The self-report measure of UL performance was the Motor Activity Log (MAL) amount of use (AOU) scale, the only measure that directly queries amount of UL use and has strong psychometric properties.¹⁰ Participants reported how much they used the paretic UL across 28 representative functional activities, with scores from 0 (did not use the paretic UL) to 5 (used the paretic UL as often as before the stroke). Because the use ratio is near unity and highly consistent in neurologically intact adults, then a score of 3 on the AOU scale (used paretic UL half as much as before the stroke) is comparable with a sensor-derived use ratio of 0.5, where the paretic UL is active half as much relative to the nonparetic limb, and a use ratio of 1 is analogous to a 5 on the MAL.⁹

Statistical analyses

Correlation analyses examined the association between the use ratio and MAL scores at both time points. Each MAL AOU value was scaled from 0 to 1 to match the range of the use ratio. The use ratio was subtracted from the scaled AOU values at each time point to create a difference score. Participants whose difference score was ± 0.1 ($\pm 10\%$) were classified as accurate reporters. Participants whose difference score was > 0.1 were classified as overreporters, and those whose difference score was < -0.1 were

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