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Title: Examining the Association Between Balance Self-Efficacy and Virtual Balance Performance In Individuals With Stroke: A Cross-Sectional Study

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Abstract (263/250 words)

Background. Balance self-efficacy is a strong predictor of fall risk after stroke and is positively related with performance on balance and walking tests. The use of telerehabilitation for delivering stroke rehabilitation has increased in recent years and there is a need to adapt common clinical assessments to be administered in virtual formats, but the association between balance self-efficacy and virtually administered clinical tests of balance performance has yet to be established. This study examined the association between the Activities-specific Balance Confidence (ABC) Scale and virtually administered Timed Up and Go (TUG) test, Tandem Stand test, and Functional Reach test (FRT) in individuals with stroke. **Methods.** This was a secondary analysis of baseline data from two telerehabilitation trials with individuals with stroke. All assessments were virtually administered by trained physical therapists through videoconferencing software. Hierarchal multivariate regression analyses were used to examine the associations between the ABC scale and TUG test, Tandem Stand test and FRT, while adjusting for age and number of comorbidities. **Results.** Fifty-one participants (n=11 female, median age=64 [IQR:18] years, 9.3 ± 4.6 months poststroke) were included in the analyses. ABC scores were associated with TUG times (R^2=0.56, F(3,47)=20.26, p<0.01), but not Tandem Stand scores (R^2=0.18, F(5,45)=1.93, p=0.11) or FRT distances (R^2=0.14, F(3,47)=2.55, p=0.07). **Conclusion.** We observed associations between the ABC scale scores and virtual TUG, but not with virtual Tandem Stand or FRT which may be attributed to the context-specificity of balance self-efficacy. As virtual administration of outcomes assessments becomes part of common practice in stroke rehabilitation, our study supports the use of virtually administered TUG and ABC in stroke.

Key Words:

1. Stroke
2. Postural Balance
3. Telerehabilitation
4. Virtual Rehabilitation
5. Self-Efficacy

6. Outcome Assessment

Word Count (3127 words)

INTRODUCTION

Stroke is the second most common cause of death and the leading cause of long-term disability worldwide.[1,2] Fall risk is a major health concern during the acute phase of stroke[3,4] and is nearly two-fold higher in the chronic phase compared to older adults without stroke,[5] with approximately 75% of individuals reporting a fall within 6 months of discharge from hospital.[6] Fear of falling is highly prevalent after stroke, reported by approximately half of cases,[7] and is associated with balance impairments and fall risk in stroke.[8] Indeed, one-quarter of individuals with stroke who report fear of falling will experience 1 to 3 falls in a 6-month period.[7] Balance self-efficacy refers to an individual's confidence in performing tasks while maintaining stability and balance.[9] It is inversely related to fear of falling and is the best predictor of future falls.[10] Of concern, individuals with stroke report low balance self-efficacy,[11] which may lead to activity avoidance,[8] beginning a cycle of muscle atrophy and deconditioning[12] and further increased risk for falls.[8] When balance self-efficacy is higher, individuals with stroke perform better on performance-based tests of balance and mobility such as quiet balance, reactive stepping and gait.[13,14]

In recent years, telerehabilitation interventions, including physical interventions have provided an avenue for delivering stroke rehabilitation programs remotely[15] and have been used to address post-stroke issues such as balance impairment. Telerehabilitation uses communication technologies to connect a healthcare professional with a patient in rural or remote locations, which allows greater access to rehabilitation services when physical access is limited.[15,16] Moreover, it serves as an avenue for individuals with transportation limitations to access to rehabilitation services.[17] This was particularly relevant throughout the SARS-CoV-2 pandemic,[16] and telerehabilitation is recommended to continue as a regular component of stroke rehabilitation even as healthcare services return to pre-pandemic levels.[16] As such, rehabilitation professionals using telerehabilitation require a means of assessing and monitoring progress of their patients.[15,16,18] Thus, there is a need to adapt common clinical assessments to be administered in virtual formats. It is possible, however, that adaptations to virtual environments such as

participant hesitancy due to safety, and accuracy of measures may alter previously established associations between balance self-efficacy and balance performance.

The objective of this study was to quantify the associations between virtually administered assessments of self-reported balance self-efficacy (Activities-Specific Balance Confidence scale) and balance performance (virtual Timed Up and Go test (TUG), Tandem Stand test and Functional Reach test), after controlling for known confounding variables. We hypothesized that there would be a moderate negative association between balance self-efficacy and virtual TUG times and positive associations with virtual Tandem Stand scores and Functional Reach distances. Due to the lower accuracy of our outcome measures compared to previous studies that utilized lab-based measures and increased risk of measurement error due to the virtual environment, we anticipate a weaker magnitude of association.[13,14]

METHODS

Study Design & Setting

This study sample was of convenience as it was a secondary analysis of baseline data collected from a feasibility study and randomized trial of the TeleRehabilitation with Aims to Improve Lower Extremity Recovery Post-Stroke (TRAIL): (ClinicalTrials.gov Identifier: NCT04265664, NCT04908241). The results from the feasibility study[19] and the protocol for the randomized trial[20] has been published. This study was reported based on the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.[21]

Participants

Volunteer participants were recruited from 5 sites (Vancouver, Winnipeg, Toronto, London, and Halifax, Canada) from the CanStroke Recovery Trials Platform which is a network of Canadian hospital sites that are affiliated with academic institutions to facilitate participant recruitment and quality trial practices. Individuals were eligible to participate in the TRAIL studies if they: 1) were ≥19 years of age; 2) experience post-stroke lower extremity hemiparesis; 3) were able to walk ≥10 meters with or without a gait aid and without physical assistance of another person; 4) were able to tolerate 50 minutes of activity to participate in the TRAIL program (including rest breaks); 5) had a support person (family member,

friend) available and capable of providing physical assistance during the assessment sessions; 6) had the cognitive-communicative ability to participate in the study. The feasibility study included individuals ≤18 months post-stroke, and the randomized trial ≤12 months post-stroke. Individuals were excluded from the studies if they: 1) were participating in formal in- or out-patient stroke rehabilitation focusing on recovery of lower extremity function; 2) were living in long-term care; 3) had severe vision or hearing loss; 4) had significant musculoskeletal or other neurological conditions; 5) were not medically stable; 6) had comorbidities (e.g. limb amputation), pain or other symptoms that significantly impact lower extremity function; 7) had planned surgery that would preclude or affect participation in the protocol. Prior to enrollment, a research coordinator provided detailed explanation of the study procedures to potential participants and answered any questions. Informed consent was obtained from all participants.

To be included in the current analysis, we used data from the TRAIL studies for participants who had available baseline scores for the Activities-Specific Balance Confidence scale, and Functional Reach, Tandem Stand, TUG tests, and covariates of age and number of comorbidities.

Virtual Assessments

All assessments were conducted virtually by trained physical therapists using secure video-conferencing software (e.g., Zoom or Microsoft Teams) while participants were in their homes.

To ensure safety throughout the assessment sessions, therapists completed a pre-participation checklist with each participant that included questions about their health status that day and to verify their location and emergency contact information. Participants were also required to have a support person present for all assessment visits who was able to provide physical assistance, safety supervision and general assistance to the therapist (managing videoconference technology, camera angles, in-person source of confirmation during assessments). Support persons were provided with instructions and a written manual in advance of the assessment visits that detailed any set-up or preparation, and how to provide safety and supervision. Any technical difficulties during outcome assessments and TRAIL sessions were recorded and reported.

Demographic information regarding participant age, sex, stroke severity assessed using the National Institute of Health Stroke Scale,[22] stroke type (ischemic, hemorrhagic, unknown), and number of chronic conditions using the Functional Comorbidity Index were collected virtually at the beginning of the assessments.

Balance Self-Efficacy

The Activities-Specific Balance Confidence (ABC) scale is a 16-item questionnaire that evaluates participants' self-efficacy in maintaining balance when performing daily activities in different settings (e.g. around the house, in a parking lot, up or down a ramp) and situations (e.g. walk down stairs, outside on icy sidewalks, bumped into by people).[23] For each situation, self-efficacy was rated on a 10-point scale ranging from 0% (no confidence) to 100% (completely confident). Scores were summed and divided by 16 to obtain a final score out of 100%, where higher scores indicate better balance self-efficacy. To facilitate virtual administration of the ABC scale, therapists shared the questionnaire on the screen to enable participants to follow along. In stroke, the in-person assessment of the ABC scale has demonstrated high internal consistency (a=0.94) and test re-test reliability (ICC=0.85).[23,24]

Clinical Assessments of Balance

Timed Up and Go. The TUG test is a clinical measure of gait-related balance and lower extremity strength that is easily administered, brief and requires little equipment.[25,26] Standardized instructions were used where participants began sitting in a sturdy chair (approximately 46 cm in height), stood up and walked at a comfortable, safe pace to a pre-marked line 3 meters away, turned around, returned to the chair, and sat down.[25] Participants were permitted to use their usual walking aid (e.g., cane, walker), however, no physical assistance was provided.[25] Time in seconds (continuous data) was recorded by the outcome assessor as the primary outcome of this test.[25] For the virtual administration of the TUG in the current study, the support person assisted by measuring and marking the 3-meter distance in advance of the assessment visit with the therapist, and by providing safety supervision during the test itself.

The TUG is a valid tool for screening balance deficits that lead to increased fall risk in older adults.[26] In stroke, the in-person TUG test has demonstrated high test-retest reliability (ICC 0.96),[27] strong convergent validity with the Berg Balance Scale (rho=0.70) and Community Balance and Mobility Scale (rho=0.75),[28] and has been recommended as an assessment tool of community ambulation levels.[29]

Functional Reach Test. The Functional Reach test (FRT) is a simple, clinically accessible test of dynamic standing balance.[30,31] Participants began standing next to but not touching a wall, with arms extended forward at 90 degrees of shoulder flexion. The starting distance was marked, then participants reached as far forward as comfortably possible without taking a step or losing their balance, and the final position marked.[31] The distance reached (continuous data) was the primary outcome of the test. In the current study, the support person measured and reported the distance reached to the therapist (in centimeters (cm)) and provided safety supervision to the participant.

In stroke, the FRT has high convergent validity with the Berg Balance Scale (rho = 0.80),[32] and established criterion validity and concurrent validity with walking speed, tandem walk, and 1-footed stand.[33]

Tandem Stand Test. The Tandem Stand test consists of progressive balance tasks for up to 10 seconds to test steady-state standing balance: 1) parallel stance (feet together side-by-side); 2) semi-tandem stance (feet at the side-by-side stance with one foot slightly forward); 3) tandem stance (one foot directly in front of the other, touching heel to toe). The scoring was adapted from the Short Physical Performance Battery,[34] where parallel and semi-tandem stances were scored as 1 point if held for at least 10 seconds and 0 points for <10 seconds, and tandem stance was scored as two points for 10 seconds, 1 point for 3 to 9.99 seconds, and 0 points for <3 seconds (ordinal data). The maximum score for the Tandem Stand test was 4, with higher scores indicating better steady-state balance.[34] In the current study, support persons provided safety supervision but did not provide assistance to achieve each stance. Support persons also either assisted with positioning the camera angle to allow the therapist to view the participant's feet or confirmed that the participant had attained each stance position if the virtual viewing angle was difficult.

In older adults, the Tandem Stand test has demonstrated the ability to predict falls,[35] has moderate test-retest reliability (r=0.66), and moderate construct validity with laboratory-based measures of balance such as difference in heel and toe pressure and area of sway.[36]

Statistical Analyses

Participant characteristics were presented using means and standard deviations for continuous data and frequencies and percentages for categorical data. Multivariate linear regression analyses were used to determine the associations between balance self-efficacy (dependent variable) and TUG times, FRT distances and scores on the Tandem Stand test (independent variables). Regression models were adjusted for known covariates of age and number of comorbidities regardless of statistical significance, as poorer balance is known to be associated with older age[37,38] and higher number of comorbidities.[37,39] Participants with missing data were excluded from the respective analysis. Variance inflation factor was used to test for multicollinearity. Visual inspection of the bivariate correlations was first examined, followed by regression diagnostics to ensure linearity, homoskedasticity, normality of residuals, any influential points, and goodness of fit. If data was deemed not linear or the assumptions of a multivariate regression were not met, a transformation was conducted based on satisfying the assumptions and interpretability. All statistical analyses were performed using Stata statistical software (Version 16.1, Stata CorpLLC, College Station, Texas, USA). The significance level was set a priori at $p<0.05$.

RESULTS

Fifty-one participants were included in this investigation: 32 from the feasibility study and 19 from the randomized trial. There was no missing data for any dependent or independent variables for the 51 participants included. Moreover, there were no major technological challenges reported during any of the assessments by the outcome assessors, support persons or participants. Participant demographic data are summarized in **Table 1**. Participants were 26 to 80 years old. The National Institute of Health Stroke Scale scores suggest that participant stroke severity ranged from moderate severity to “no symptoms”. Our sample presented with possible walking-related balance impairment, evidenced by mean time to

complete TUG more than two-fold higher than older adults (n=4395),[40] and lower mean balance self-efficacy (n=371).[41,42] FRT distances was similar to those reported in older adults (n=7535).[43]

For the analysis between balance self-efficacy and TUG times, assumptions for homoscedasticity were not met; thus, TUG times were transformed to the natural logarithm (ln) of the original units. Unadjusted and adjusted regression models are presented in Table 2. In the unadjusted models, balance self-efficacy was associated with the natural logarithm TUG times (R^2=0.51, F(1,49)=51.46, p<0.01), FRT distances (R^2=0.10, F(1,49)=5.57, p=0.02), but not tandem stand scores (R^2=0.13, F(3,47)=2.44, p=0.40). After adjusting for age and number of chronic diseases, the association remained between balance self-efficacy and the natural logarithm of TUG times (R^2=0.56, F(3,47)=20.26, p<0.01) (Figure).

There were no significant associations between balance self-efficacy and FRT distances or Tandem Stand scores in the adjusted models (Table 2).

DISCUSSION

We report a negative association between balance self-efficacy and virtually-administered TUG times among individuals with stroke. This is aligned with previous studies[13,14] which observed similar associations with quiet balance, reactive stepping and gait. However, we did not find associations between balance self-efficacy and Tandem Stand scores or FRT distances. The inconsistency in findings is contrary to our hypotheses but may be attributed to the nature of the questions of the ABC scale where there may be closer alignment with some tests of physical performance more than others. Self-efficacy is highly context-specific,[44] and thus balance self-efficacy will differ across contexts and conditions. Among the 16 items of the ABC scale, we posit that 12 questions are related to balance during walking activities (e.g. walk outside the house to a car parked in the driveway, walking around the house) which would align most closely with the walking-focused TUG. In contrast, there are no items on the ABC related directly to balance self-efficacy during steady-state standing activities similar to Tandem Stance test, and only 4 items related to dynamic reaching (e.g. reach for a small can off a self at eye level, stand on a chair and reach for something)[24] analogous to the FRT. Additionally, given the virtual nature of this study,

there may have been a potential for inaccuracies in the FRT, as attempts were measured by support personnel rather than by the therapist.

The null association observed between ABC and steady-state standing performance may also be explained in part by the psychometric properties and the ordinal scoring of the Tandem Stand test. Peng et al. recently reported low convergent validity of the virtual Tandem Stand test with in-person clinical tests of gait-related balance such as walking speed (r=0.13), 6-Minute Walk Test (r=0.12), and Community Balance and Mobility scale (r=0.38) among individuals with stroke.[45] The scoring of the Tandem Stand test was adapted from the Short Physical Performance Battery[34] to use a 4-point ordinal scale, and may have been subject to a ceiling effect and thus reduced sensitivity to detect an association compared to a test with continuous scoring.[46] We noted that the majority of participants (65%) scored the maximum 4 points and only one participant scored 1 point; raw scores (in seconds) were not recorded and participants held each position for up to 10 seconds only. Future work may include larger sample sizes with more distributed scores on the Tandem Stand, consider recording time as a continuous scale or expanding the maximum allowable time held for greater sensitivity and a larger range of datapoints.

The inverse association between balance self-efficacy and TUG times observed in the current study extend the previously reported associations from in-person assessments[13,14] to the virtual environment. This implies the use of a virtual TUG test in stroke telerehabilitation programs. These similarities may also be attributed to the established high convergent validity of the TUG test with other assessments of gait-related balance in individuals with stroke (6-Minute Walk Test, stair ascending and descending, and Dynamic Gait Index) during in-person[47] and virtual assessments.[45] This is important for stroke rehabilitation particularly when patient goals are focused on balance and mobility such as walking, sit-stand, and turning, components that comprise the TUG test.[48] Stroke telerehabilitation programs that may improve TUG performance[15] may be associated with increased balance self-efficacy and thus increased poststroke physical activity[12] and reduced risk of falls.[8]

We acknowledge the limitations of the study. There may be sampling bias as all participants were required to have access to technology and have a support person present to participate in the larger

studies. Next, the self-report nature of the ABC scale is subject to social desirability and recall bias.[49] Moreover, we did not have a representative proportion of males and females for the broader stroke population, with 22% females in the current study vs. approximately 53% in the general stroke population.[50] Thus, we were not powered to include biological sex as a covariate or disaggregate our results by sex. Future studies should aim to include a representative proportion of females to allow for sex to be included as a covariate in the analysis, given that females are more likely to fall than males.[51] Doing so would provide a better understanding of the relationship between the variables and improve the generalizability of the findings to both males and females.

CONCLUSION

This study identified an association between balance self-efficacy as measured by the ABC scale and a gait-related measure of balance (TUG test) conducted in a virtual environment, but not with tests of steady-state (Tandem stand test) and dynamic standing balance (FRT) in individuals with stroke. As the body of evidence supporting telerehabilitation to improve balance and walking after stroke increases, this study supports the use of virtually administered TUG and ABC to quantify gait-related balance and balance self-efficacy in stroke.

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References

1. Dorrance AM, Fink G. Effects of Stroke on the Autonomic Nervous System. *Compr Physiol*. Jul 1 2015;5(3):1241-63. doi:10.1002/cphy.c140016

2. Donkor ES. Stroke in the 21(st) Century: A Snapshot of the Burden, Epidemiology, and Quality of Life. *Stroke Res Treat*. 2018;2018:3238165. doi:10.1155/2018/3238165

3. Weerdesteyn V, Niet Md, van Duijnhoven HJR, Geurts ACH. Falls in individuals with stroke. *The Journal of Rehabilitation Research and Development*. 2008;45(8)doi:10.1682/JRRD.2007.09.0145

4. Davenport RJ, Dennis MS, Wellwood I, Warlow CP. Complications after acute stroke. *Stroke*. Mar 1996;27(3):415-20. doi:10.1161/01.str.27.3.415

5. Jørgensen L, Engstad T, Jacobsen BK. Higher incidence of falls in long-term stroke survivors than in population controls: depressive symptoms predict falls after stroke. *Stroke*. Feb 2002;33(2):542-7. doi:10.1161/hs0202.102375

6. Forster A, Young J. Incidence and consequences of falls due to stroke: a systematic inquiry. *Bmj*. Jul 8 1995;311(6997):83-6. doi:10.1136/bmj.311.6997.83

7. Ng SS. Contribution of subjective balance confidence on functional mobility in subjects with chronic stroke. *Disabil Rehabil*. 2011;33(23-24):2291-8. doi:10.3109/09638288.2011.568667

8. Liu TW, Ng GYF, Chung RCK, Ng SSM. Decreasing Fear of Falling in Chronic Stroke Survivors Through Cognitive Behavior Therapy and Task-Oriented Training. *Stroke*. Dec 7 2018:STROKEAHA118022406. doi:10.1161/STROKEAHA.118.022406

9. Powell LE, Myers AM. The Activities-specific Balance Confidence (ABC) Scale. *J Gerontol A Biol Sci Med Sci*. Jan 1995;50a(1):M28-34. doi:10.1093/gerona/50a.1.m28

10. Landers MR, Oscar S, Sasaoka J, Vaughn K. Balance Confidence and Fear of Falling Avoidance Behavior Are Most Predictive of Falling in Older Adults: Prospective Analysis. *Phys Ther*. Apr 2016;96(4):433-42. doi:10.2522/ptj.20150184

11. Watanabe Y. Fear of falling among stroke survivors after discharge from inpatient rehabilitation. *Int J Rehabil Res*. Jun 2005;28(2):149-52. doi:10.1097/00004356-200506000-00008

12. Lachman ME, Howland J, Tennstedt S, Jette A, Assmann S, Peterson EW. Fear of falling and activity restriction: the survey of activities and fear of falling in the elderly (SAFE). *J Gerontol B Psychol Sci Soc Sci*. Jan 1998;53(1):P43-50. doi:10.1093/geronb/53b.1.p43

13. Schinkel-Ivy A, Inness EL, Mansfield A. Relationships between fear of falling, balance confidence, and control of balance, gait, and reactive stepping in individuals with sub-acute stroke. *Gait Posture*. Jan 2016;43:154-9. doi:10.1016/j.gaitpost.2015.09.015

14. Schinkel-Ivy A, Wong JS, Mansfield A. Balance Confidence Is Related to Features of Balance and Gait in Individuals with Chronic Stroke. *J Stroke Cerebrovasc Dis*. Feb 2017;26(2):237-245. doi:10.1016/j.jstrokecerebrovasdis.2016.07.022

15. Laver KE, Adey-Wakeling Z, Crotty M, Lannin NA, George S, Sherrington C. Telerehabilitation services for stroke. *Cochrane Database Syst Rev*. Jan 31 2020;1:CD010255. doi:10.1002/14651858.CD010255.pub3

16. Salbach NM, Mountain A, Lindsay MP, et al. Canadian Stroke Best Practice Recommendations: Virtual Stroke Rehabilitation Consensus Statement 2022. *Am J Phys Med Rehabil*. Jun 29 2022;doi:10.1097/phm.0000000000002062

17. Oluyede L, Cochran AL, Wolfe M, Prunkl L, McDonald N. Addressing transportation barriers to health care during the COVID-19 pandemic: Perspectives of care coordinators. *Transp Res Part A Policy Pract*. May 2022;159:157-168. doi:10.1016/j.tra.2022.03.010

18. Jagos H, David V, Haller M, et al. A Framework for (Tele-) Monitoring of the Rehabilitation Progress in Stroke Patients: eHealth 2015 Special Issue. *Appl Clin Inform*. 2015;6(4):757-68. doi:10.4338/ACI-2015-03-RA-0034

19. Park S, Tang A, Barclay R, et al. Investigating the Telerehabilitation With Aims to Improve Lower Extremity Recovery Poststroke Program: A Feasibility Study. *Phys Ther*. Mar 1 2024;104(3)doi:10.1093/ptj/pzad165

20. Sakakibara BM, Wiley E, Barclay R, et al. TeleRehabilitation with Aims to Improve Lower extremity recovery in community-dwelling individuals who have had a stroke: protocol for a multisite, parallel group, assessor-blinded, randomised attention-controlled trial. *BMJ Open*. Jul 19 2023;13(7):e076723. doi:10.1136/bmjopen-2023-076723

21. von Elm E, Altman DG, Egger M, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *BMJ*. Oct 20 2007;335(7624):806-8. doi:10.1136/bmj.39335.541782.AD

22. Brott T, Adams HP, Jr., Olinger CP, et al. Measurements of acute cerebral infarction: a clinical examination scale. *Stroke*. Jul 1989;20(7):864-70. doi:10.1161/01.str.20.7.864

23. Salbach NM, Mayo NE, Hanley JA, Richards CL, Wood-Dauphinee S. Psychometric evaluation of the original and Canadian French version of the activities-specific balance confidence scale among people with stroke. *Arch Phys Med Rehabil*. Dec 2006;87(12):1597-604. doi:10.1016/j.apmr.2006.08.336

24. Botner EM, Miller WC, Eng JJ. Measurement properties of the Activities-specific Balance Confidence Scale among individuals with stroke. *Disabil Rehabil*. Feb 18 2005;27(4):156-63. doi:10.1080/09638280400008982

25. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. *J Am Geriatr Soc*. Feb 1991;39(2):142-8. doi:10.1111/j.1532-5415.1991.tb01616.x

26. Nightingale CJ, Mitchell SN, Butterfield SA. Validation of the Timed Up and Go Test for Assessing Balance Variables in Adults Aged 65 and Older. *J Aging Phys Act*. Apr 1 2019;27(2):230-233. doi:10.1123/japa.2018-0049

27. Flansbjer UB, Holmback AM, Downham D, Patten C, Lexell J. Reliability of gait performance tests in men and women with hemiparesis after stroke. *J Rehabil Med*. Mar 2005;37(2):75-82. doi:10.1080/16501970410017215

28. Knorr S, Brouwer B, Garland SJ. Validity of the Community Balance and Mobility Scale in community-dwelling persons after stroke. *Arch Phys Med Rehabil*. Jun 2010;91(6):890-6. doi:10.1016/j.apmr.2010.02.010

29. An SH, Park D-S, Lim JY. Discriminative validity of the timed up and go test for community ambulation in persons with chronic stroke. *Physical Therapy Rehabilitation Science*. 2017;6(4):176-181. doi:10.14474/ptrs.2017.6.4.176

30. Duncan PW, Studenski S, Chandler J, Prescott B. Functional reach: predictive validity in a sample of elderly male veterans. *J Gerontol*. May 1992;47(3):M93-8. doi:10.1093/geronj/47.3.m93

31. Duncan PW, Weiner DK, Chandler J, Studenski S. Functional reach: a new clinical measure of balance. *J Gerontol*. Nov 1990;45(6):M192-7. doi:10.1093/geronj/45.6.m192

32. Smith PS, Hembree JA, Thompson ME. Berg Balance Scale and Functional Reach: determining the best clinical tool for individuals post acute stroke. *Clin Rehabil*. Nov 2004;18(7):811-8. doi:10.1191/0269215504cr817oa

33. Weiner DK, Duncan PW, Chandler J, Studenski SA. Functional reach: a marker of physical frailty. *J Am Geriatr Soc*. Mar 1992;40(3):203-7. doi:10.1111/j.1532-5415.1992.tb02068.x

34. Guralnik JM, Simonsick EM, Ferrucci L, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol*. Mar 1994;49(2):M85-94. doi:10.1093/geronj/49.2.m85

35. Phelan EA, Mahoney JE, Voit JC, Stevens JA. Assessment and management of fall risk in primary care settings. *Med Clin North Am*. Mar 2015;99(2):281-93. doi:10.1016/j.mcna.2014.11.004

36. Rossiter-Fornoff JE, Wolf SL, Wolfson LI, Buchner DM. A cross-sectional validation study of the FICSIT common data base static balance measures. Frailty and Injuries: Cooperative Studies of Intervention Techniques. *J Gerontol A Biol Sci Med Sci*. Nov 1995;50(6):M291-7. doi:10.1093/gerona/50a.6.m291

37. Welmer AK, Kareholt I, Angleman S, Rydwik E, Fratiglioni L. Can chronic multimorbidity explain the age-related differences in strength, speed and balance in older adults? *Aging Clin Exp Res*. Oct 2012;24(5):480-9. doi:10.3275/8584

38. Takeshima N, Islam MM, Rogers ME, et al. Pattern of age-associated decline of static and dynamic balance in community-dwelling older women. *Geriatr Gerontol Int*. Jul 2014;14(3):556-60. doi:10.1111/ggi.12132

39. Spruit-van Eijk M, Zuidema SU, Buijck BI, Koopmans RT, Geurts AC. To what extent can multimorbidity be viewed as a determinant of postural control in stroke patients? *Arch Phys Med Rehabil*. Jun 2012;93(6):1021-6. doi:10.1016/j.apmr.2012.01.004

40. Bohannon RW. Reference values for the timed up and go test: a descriptive meta-analysis. *J Geriatr Phys Ther*. 2006;29(2):64-8. doi:10.1519/00139143-200608000-00004

41. Huang TT, Wang WS. Comparison of three established measures of fear of falling in community-dwelling older adults: psychometric testing. *Int J Nurs Stud*. Oct 2009;46(10):1313-9. doi:10.1016/j.ijnurstu.2009.03.010

42. Nemmers TM, Miller JW. Factors influencing balance in healthy community-dwelling women age 60 and older. *J Geriatr Phys Ther*. 2008;31(3):93-100. doi:10.1519/00139143-200831030-00003

43. Bohannon RW, Wolfson LI, White WB. Functional reach of older adults: normative reference values based on new and published data. *Physiotherapy*. Dec 2017;103(4):387-391. doi:10.1016/j.physio.2017.03.006

44. Usher EL, Urdan T. Self-Efficacy. In: Friedman HS, ed. *Encyclopedia of Mental Health (Second Edition)*. Academic Press; 2016:75-79.

45. Peng T-H, Harris A, Tang A, Sakakibara B, Eng JJ, Pollock CL. Clinical Measures of Balance and Walking Ability in People with Stroke for Assessment via Videoconferencing. *Physiotherapy Canada*. 2023;doi:10.3138/ptc-2022-0039

46. Verhulst B, Neale MC. Best Practices for Binary and Ordinal Data Analyses. *Behav Genet*. May 2021;51(3):204-214. doi:10.1007/s10519-020-10031-x

47. Hafsteinsdóttir TB, Rensink M, Schuurmans M. Clinimetric properties of the Timed Up and Go Test for patients with stroke: a systematic review. *Top Stroke Rehabil*. May-Jun 2014;21(3):197-210. doi:10.1310/tsr2103-197

48. Teasell R, Salbach NM, Foley N, et al. Canadian Stroke Best Practice Recommendations: Rehabilitation, Recovery, and Community Participation following Stroke. Part One: Rehabilitation and Recovery Following Stroke; 6th Edition Update 2019. *Int J Stroke*. Oct 2020;15(7):763-788. doi:10.1177/1747493019897843

49. Althubaiti A. Information bias in health research: definition, pitfalls, and adjustment methods. *J Multidiscip Healthc*. 2016;9:211-7. doi:10.2147/JMDH.S104807

50. Krueger H, Koot J, Hall RE, O'Callaghan C, Bayley M, Corbett D. Prevalence of Individuals Experiencing the Effects of Stroke in Canada: Trends and Projections. *Stroke*. Aug 2015;46(8):2226-31. doi:10.1161/STROKEAHA.115.009616

51. Nascimento MM, Gouveia ER, Gouveia BR, et al. Sex Differences in Falls: The Mediating Role of Gait Stability Ratio and Body Balance in Vulnerable Older Adults. *J Clin Med*. Jan 5 2023;12(2)doi:10.3390/jcm12020450

Table 1. Participant demographics

	Total (n=51)	Males (n=40)	Females (n=11)
Age, median (IQR)	64 (18)	62.5 (18.5)	68 (20)
Time Post-stroke (Months), mean ± SD	9.3 ± 4.6	10.3 ± 4.5	5.8 ± 2.7
National Institute of Health Stroke Scale, median (IQR)	3 (3)	3 (3)	2 (3)
Stroke Type			
Infarct	28 (54.9%)	26 (65.0%)	2 (18.2%)
Hemorrhagic	12 (23.5%)	9 (22.5%)	3 (27.3%)
Unknown	11 (21.6%)	5 (12.5%)	6 (54.6%)
Number of Comorbidities, median (IQR)	3 (2)	3 (3)	3 (2)
Montreal Cognitive Assessment Score, median (IQR)	13 (2)	13 (2)	13 (3)
Timed Up and Go (s), mean ± SD	20.5 ± 18.8	19.9 ± 20.1	22.6 ± 13.2
Functional Reach (cm), mean ± SD	27.3 ± 9.0	28.0 ± 9.3	24.7 ± 7.3
Tandem Stand Score (n) %			
1	1 (2.0%)	1 (2.5%)	0 (0%)
2	7 (13.7%)	5 (12.5%)	2 (18.2%)
3	10 (19.6%)	5 (12.5%)	5 (45.5%)
4	33 (64.7%)	29 (72.5%)	4 (36.4%)
Activities-specific Balance Confidence Scale Score, mean ± SD	68.1 ± 20.1	70.0 ± 20.7	61.3 ± 17.2

Note. IQR= Interquartile Range, SD= Standard Deviation

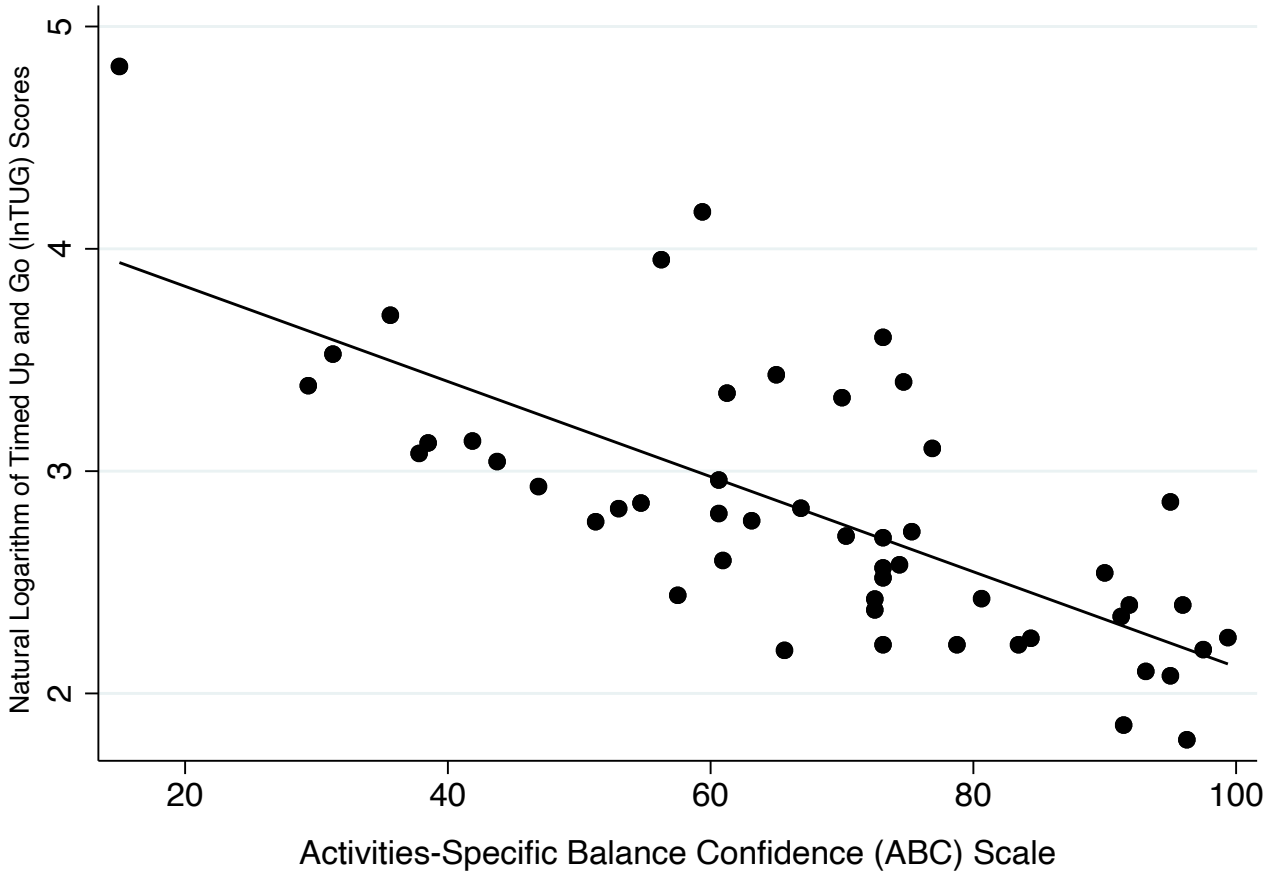
Natural Logarithm of Timed Up and Go (lnTUG) Scores
2
3
4
5
20
40
60
80
100
Activities-Specific Balance Confidence (ABC) Scale

Table 2. Association between Balance Self-Efficacy and Clinical Measures of Balance Adjusted for Age and Number of Chronic Diseases

	Unadjusted			Adjusted		
	β (SE)	**95% CI**	R^2	**β (SE)**	**95% CI**	R^2
lnTUG	-23.94 (3.34)*	-30.64 to -17.23	0.51	-23.65 (3.27)*	-30.23 to -17.07	0.56
Functional Reach	0.72 (0.30)†	0.11 to 1.33	0.10	0.59 (0.32)	-0.06 to 1.24	0.14
Tandem Stand *(ref: Score 1)*			0.13			0.18
Score 2	17.66 (20.66)	-23.91 to 59.23		10.68 (21.34)	-32.09 to 53.46	
Score 3	25.63 (20.27)	-15.15 to 66.41		20.17 (20.65)	-21.42 to 61.76	
Score 4	34.21 (19.62)	-5.26 to 73.68		26.58 (20.24)	-14.20 to 67.35	

Note. SE= Linearized Standard Error, CI= Confidence Interval, lnTUG= Natural logarithm of Timed up and Go times, *denotes $p<0.01$, †denotes $p<0.05$

Figure Captions

Figure. Association between Activities-specific Balance Confidence Scale Score and Natural logarithm of Timed up and Go times.