Age Moderates Differences in Performance on the Instrumented Timed Up and Go test between People with Dementia and their Informal Caregivers

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Title

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Abstract

Introduction

The instrumented Timed Up and Go test (iTUG) affords quantification of the sub-elements of the Timed Up and Go test to assess falls risk and physical performance. A miniature sensor applied to the back is able to capture accelerations and velocities from which the sub-elements of the iTUG can be quantified. This study is the first to compare iTUG performance between people with dementia (PWD) and their age matched caregivers. The aims of this study were to explore how age moderates the differences in performance on the instrumented Timed Up and Go test between PWD and their informal caregivers.

Methods

Eight-three community dwelling older PWD and their informal caregivers were recruited for this cross sectional, observational study. Participants were grouped by age; <70 years, 70-79 years and 80+ years old. Participants wore an inertial sensor while performing the iTUG in their home. The performance of the sub-elements sit to stand, walking and turning were captured through an algorithm converting accelerations and velocities into performance metrics such as duration and peak velocity. Performance for PWD were compared to caregivers for each age matched group and multiple regression models incorporating age, gender and presence or absence of dementia were computed.

Results

PWD took longer to turn in <70 year group, suggesting this may be an early indicator of functional decline in this age group. PWD took longer to complete the whole iTUG compared to caregivers in the 70-79 year old group. In the 80+ year old group PWD took longer to complete both walking

phases, sit-to-stand and the full iTUG along with displaying slower turning velocity. Multiple regression models illustrated that gender failed to contribute significantly to the model, but age and presence of dementia explained around 30% of the variance of time to complete walking phases, total iTUG and turning velocity.

Conclusions

Differences were evident in performance of the iTUG between PWD and caregivers even after controlling for age. Age moderates the differences observed in performance.

Key words

Inertial sensor, aging, dementia, balance, motor performance, timed up and go

INTRODUCTION

Falls in later life are globally recognised as a major public health issue.[1] Among adults aged 65 and above, falls are the leading cause for emergency department presentation.[2] Approximately 10% of falls among those aged 75 or above result in hip fracture,[3] and only around a quarter of these patients return to their pre-fracture level of functioning within 90 days.[4] Falls are often the reason for an older person to be admitted into long term residential care,[3] and are associated with reduced social participation from a fear of falling and increased costs to health and social services.[1,5,6]

The risk of falls is higher among subgroups of the older population. The risk of falls increases with age[3] and is different between men and women; women fall more often than men but men have more fatal falls.[1] Another risk factor for falls is dementia; a degenerative neurological disease characterised by a chronic, global, and non-reversible loss of cognitive functioning.[8] Estimates suggest that 46.8 million people had dementia in 2015 and that this figure will rise to 131.5 million worldwide by 2050.[9] People with dementia (PWD) are more than twice as likely to fall and twice as likely to experience injurious falls compared to their cognitively intact peers.[10,11] In addition, PWD are more likely to experience adverse health outcomes after injurious falls during their hospital stay and after discharge such as hospital readmission, institutionalisation, and mortality.[12,13,14]

The Timed Up and Go test (TUG) is one of the most frequently used tests to quantify physical function and falls risk for older adults.[15,16] The TUG records time (seconds) to complete a continuous series of tasks (stand from a sitting position, walk 3 meters, turn and walk back finishing by returning to a sitting position). Previous research has proposed a threshold of 13.5 seconds or longer being associated with greater falls risk.[16] The TUG is quick to administer but is criticized for providing a single value for a task involving multiple transitions, walking and turning all based on differing physiological constructs.[17] In addition, there is evidence supporting a lack of prospective validity of the TUG to predict falls.[18,19] A more detailed instrumented version of the TUG (iTUG), where the individual wears a body sensor on the low back during the test, generates metrics for each of the motor sub-elements of the TUG: peak acceleration and duration of the initial sit to stand; duration, regularity and symmetry of walking phases; as well as velocity and duration of the turning phases has been proposed.[20] These sub-elements include the sit to stand phase, where peak accelerations and duration is quantified; the walking phases, where duration and metrics of regularity and symmetry are quantified and turning phases, where peak turning velocity and duration are quantified. These sub-phases are identified though identification of accelerations and velocities which physiologically correspond to those relative movements, captured by body worn sensors. The iTUG has been found to offer good repeated measures reliability and validity.[20,21,22,23,24] The iTUG offers greater discriminatory ability for performance deficits than time to complete TUG [25,26,27] and therefore may offer early insights into physical impairments. The iTUG sub-elements have been used to detect performance differences between people with mild cognitive impairment and age-matched peers,[25] and to explore relationships between cognitive function, fear of falling and quality of life among PWD.[28] However, iTUG performance has yet to be compared between PWD and age-matched peers. Therefore, the aims of this study were to explore how age moderates the differences in performance on the instrumented Timed Up and Go test between PWD and their informal caregivers. This will provide new insights into the iTUG performance deficits of dementia independent of age.

METHODS

This cross section observational study used baseline data collected during the TACIT trial (NTC02864056), a randomized controlled trial to test the effects of Tai Chi on postural balance and falls in PWD and their informal caregivers.[29] This study was approved by the West of Scotland Research Ethics Committee 4 (reference: 16/WS/0139 and the Health Research Authority (IRAS project ID: 209193).

Participants

Eighty-three persons with dementia and their informal caregiver were recruited from NHS databases, memory clinics, local charities and through self-referral from across the South of England. As this study used baseline data from the TACIT trial, inclusion criteria reflected recruitment for the TACIT trial. Caregivers needed to be living with the person with dementia or able to visit at least twice a week, able to participate in standing Tai Chi, and be able to commit to supporting the PWD in data collection and in Tai Chi weekly classes and home practice. Exclusion criteria included those caregivers with severe sensory impairment or lacked mental capacity to provide informed consent. PWD were included if they were aged 18 or more; lived at home; had a diagnosis of dementia (indicated on their medical record held by the national health service or general practitioner) and willing and able to complete standing Tai Chi (as part of the TACIT trial). PWD were excluded if they lived in a long term residential care facility; were in receipt of palliative care; scored <=9 on the Mini-Addenbrooke's Cognitive Evaluation (M-ACE);[30] had Lewy body dementia or dementia with Parkinson's Disease; severe sensory impairment; were currently under the care of or had been referred to a falls clinic for assessment, currently attending a balance exercise program (e.g. Otago classes), or lacked mental capacity to provide informed consent. In addition participants were excluded if they had completed Tai Chi or similar exercise (yoga, Qi gong, or Pilates) once a week or more within six months of the commencement of the study.

The sample size was based on that used for the Tacit trial.[29] This was to recruit a sample of 120, powered for a difference of 4 seconds in total time to complete TUG, with a standard deviation of 0.38, a correlation of 0.7 and a 2-sided 5% significance level and 90% power. While the recruited sample was below target at 83 PWD and their informal caregivers, we obtained smaller standard deviations than estimated for the TUG and the estimated smallest detectable change of a value of 4 was outside the 95% confidence interval (-2,17, 3.81) between the trial arms, suggesting that the testing on the TUG was adequately powered.

Instrumented Timed Up and Go test

Data were collected by a single investigator trained in the use of the iTUG during a visit at the PWD and caregiver's home. Each performed a standardized iTUG once the sensor was placed on their low back: rising for a chair, walking 3 meters to a mark on the floor, turning, then walking back to the chair, and returning to sitting. Participants were free to choose turning direction and a pragmatic approach to the particular chair available within the individuals' home was used. Participants were encouraged to not use arm rests and were permitted to use their 'usual' walking aid, however only one person in the older PWD group used a cane during testing. Previous studies have demonstrated excellent reliability for total time to complete Timed-Up and Go and a range of minimal detectable change (MDC) values across a variety of clinical presentations, ranging from ICC=0.81, MDC=4.4s for persons with early Dementia [31] to ICC=0.97, MDC 1.1s for older adults with osteoarthiritis.[32]

A trunk mounted inertial measurement unit (Balance Sensor, THETAmetrix, Portsmouth, UK) was mounted over the middle of the individuals low back, reinforced with an elasticated strap. The Inertial Measurement Unit (IMU) incorporates a triaxial accelerometer and triaxial gyroscope providing linear accelerations and rotational velocities at 30Hz. Excellent reliability of the IMU has been previously reported.[33] Data were exported to matlab for feature extraction. An automated algorithm was used to detect the sub-phases of the iTUG, as has been previously described.[28] Data were filtered at 6Hz to remove high frequency noise. Temporal events and sub-phases were identified by local maxima/minima detection and zero crossing points from the respective acceleration and gyroscope traces. In addition, walking periods of the iTUG were used to compute measures of regularity (ACstep, ACstride) and symmetry (ratio) using autocorrelation methods.[34] The variables investigated in this study are presented in table 1.

Statistical analysis

All data were assessed for normality using Shapiro-Wilk testing from which appropriate parametric and non-parametric statistics were followed. The two groups (PWD and Caregivers) differed significantly in age (p = 0.015), therefore two approaches were adopted to control for age. First, age brackets were defined for each group of young (<70 years (range age of youngest participant to 69.9 years)), middle (70-79 years), and older (80+ (range 80 to oldest participant)), from which independent t-tests or Mann Whitney-U tests were used to identify differences between PWD and Caregivers. These groupings were chosen to ensure similar amounts of the sample were present in each group (30%, 33% and 37% respectively). In addition multivariate regression models for each iTUG variable were explored with age, gender and diagnosis (PWD or Caregiver) as independent variables. To avoid type 1 error due to the multiple testing, we used Bonferroni corrections to reduce alpha from 0.05 to 0.004. Cohen's-d effect sizes were calculated to determine the magnitude of difference between groups.

RESULTS

The frequency of gender and age range for the groups is presented in table 2. There was a propensity for caregivers to be female with a higher proportion in the younger age group compared to PWD. No significant differences were evident in the ages of the groups following categorization (table 3), however there was a wider age range for the young group of caregivers.

Age group categorization and statistical results for comparison between caregivers and PWD are presented in tables 3-5. The younger age group comparisons (table 3) demonstrated that, following Bonferroni correction, only time taken to complete the turn was significantly different between the groups. However large effect sizes (d>0.8), which in contrast to statistical testing are used to quantify the magnitude of the observed effect, were observed between the two groups for standing acceleration, time to complete walking phase 2, total TUG time and gait asymmetry during walk phase 1. The middle age group comparisons (table 4) demonstrated that PWD took significantly longer to complete the total iTUG. The older age group comparisons (table 5) demonstrated that PWD took significantly longer to complete sit-to-stand, both walking phases, total iTUG and turning velocity was lower. Large effect sizes were determined for time to complete both walking phases and the total iTUG in addition to turning velocity and step regularity during walk phase 2.

Multivariate regression models were sequentially built to determine if the inclusion of age, gender, and presence/absence of dementia (independent variables) might predict each specific iTUG variable (dependent variable). This sequential process enabled the understanding of the impact of adding each independent variable to the model. Details of the model and contribution are displayed in table 6. Gender made no difference to the predictive capacity of the regression model, but adding dementia diagnosis improved the predictive capacity. The model explained 26% - 33% of the variance of time to complete the walking phases and total time to complete iTUG. Regarding turning, the model explained 21% - 28% of turning velocity and 15% of the variance of time to turn. The higher percentages of variances explained for each significant variable were from the model with dementia diagnosis added.

Discussion

The aims of this study were to explore how age moderates the differences in performance on the instrumented Timed Up and Go test between PWD and their informal caregivers. The novel sensor technology and derived algorithms were capable of quantifying the sub-phases of iTUG and demonstrated that age moderates the differences in iTUG performance observed between PWD and caregivers. As all testing was completed in the individuals homes this offers a significant potential for quantification of performance in clinical practice.

Differences between PWD and caregivers in the youngest age group (<70 years of age) were demonstrated for time for turn, and may offer early indications of deterioration in function. PWD took around 20% longer (0.4 seconds) to complete the turn than caregivers of a similar age. Turning has been identified as a complex task requiring a coordinated sequence of axial rotations of multiple body parts,[35] all of which may require longer processing in PWD. In addition, large effect sizes were identified for standing acceleration, gait symmetry, time to walk phase 2 and total time to complete iTUG. These did not meet the stringent criteria for Bonferroni correction, however the magnitude of actual difference was similar (around 20%). Total time to complete was quite variable in PWD (coefficient of variation (calculated by dividing the mean by the standard deviation) = 54%), suggesting great variability in performance of the whole iTUG across the group. In addition the observed difference between the groups was 3.4s, slightly below that identified as the MDC[31]. Standing acceleration was much less variable, while still demonstrating a large effect size between groups, suggesting this could be used as a key performance indicator in younger PWD. Sit-to-stand acceleration may represent early deficits in power from the lower limbs.[17]

The middle aged group (70-79 years of age) demonstrated total time to complete iTUG was significantly different with the greatest statistical confidence and around a 20% real difference. This finding is in line with numerous studies identifying deficits in total time to complete iTUG in frail older adults[36,37] and in fallers,[38] and now in those with dementia. This demonstrates that total time identifies performance difference even when controlled for age. Despite this the effect size was only moderate and the magnitude of difference between groups was below that of the MDC identified previously.[31] Total time to complete TUG has been strongly correlated to time to complete walking phases.[28] Therefore, it is highly likely that walking speed is a significant contributor to overall iTUG time. In addition turning time demonstrated the largest effect size (0.775) suggesting this slowed speed was sustained from the younger age group, despite the fact that the caregivers in this age group took slightly longer to turn than the younger caregivers.

The divergence in metrics is much clearer in the older group (80+ years of age). Walking durations, turning velocity and sit to stand time were prolonged suggesting a strong down gearing of movement velocity with actual differences of around 25%. This suggests a loss of around a quarter of these higher functions. This is corroborated by effect size analysis where large effect sizes were determined for the above variables, except sit to stand time. There seems to be little difference in these values for the caregivers as they age, but a sharper drop in performance in PWD noted between the 70 and 80+ year old group. It is possible that this is due to a progression in dementia impacting on performance, illustrating that as the disease progresses the performance declines resulting in the divergence observed after 80 years of age. However, despite our previous study demonstrating that walk time and TUG time were correlated with dementia disease severity (as measured using the M-ACE), the strength of the relationship was weak at 0.25-0.28 and non-existent for other sub-phases of the iTUG.[28] This throws into question the mechanism behind such marked deficits observed in the older age group. The current findings illustrate that it is not simply age, and our previous findings illustrate it is not simply disease severity that reduces performance on the iTUG and its subtasks. This is corroborated further by our multivariate models that showed an increased variance explained by adding dementia diagnosis to age as the predictor variables. This suggests that a more complex multifactorial explanation is required. It is possible that fear of falling is important as this correlated with iTUG in PWD, explaining up to 20% of total time to complete iTUG.[28] However perhaps deconditioning plays an important role also,[39,40,41] where activity down-regulation results in a reduction in physical capacity.

The findings from this study have a number of important clinical implications. Firstly the results demonstrate that the sub-phases of the iTUG are able to detect differences in PWD from their age-matched caregivers, thus separating out those changes due to age versus those due to Dementia. Such deficits are different depending on the age bracket investigated with most divergence evident over 80 years of age. Deficits identified in the under 70 year old bracket were quite pronounced and may offer early clinical targets for intervention to minimize functional decline.

These deficits were only visualized with the addition of the instrumented Timed Up and Go test, such as standing acceleration, suggestive of a decline in lower limb power. As individuals age, other sub-phases may offer clues for functional deficits demonstrating the importance of an assessment which offers a detailed breakdown of the iTUG. This probably reflects the underlying complexity pertaining to the iTUG with its differing physiological constructs underpinning its differing sub-phases. The ability to assess these complex tasks not only differentiates between performances of PWD but is able to evaluate early changes in function offering highly specific clinical rehabilitation targets.

Despite being commercially available, devices and algorithms for quantifying iTUG are not commonplace in clinical practice. In the absence of such methods, the findings of this study can still guide clinicians in their approach to assessment and management of PWD. Understanding that specific elements, such as sit to stand, may be the first clues to deterioration of function in PWD under 70 years old. Many assessment strategies exist to quantify performance of sit to stand and the findings of the current study encourages clinicians to integrate such assessment for PWD under 70 years old. Assessment of individuals in the 70-79 demonstrate the original total time to complete TUG is able to detect differences and so should remain as an important variable for assessing function in this age group. Therefore clinicians should be mindful that age moderates the performance of the iTUG differently for caregivers and PWD.

There are several limitations with this study. A cross-sectional design was used therefore no inferences about causation can be made. The age group categorizations resulted in unequal group sizes. The data were collected in individual's homes therefore a pragmatic approach was taken towards chair height and a standard 3m Timed Up and Go was adopted which can affect the ability to use autocorrelation analysis methods. Future research could aim to determine if the identified performance deficits in iTUG sub-phase are modified with rehabilitation in PWD such as to prevent functional decline.

CONCLUSION

This study demonstrated significant differences in performance of specific elements of the iTUG in PWD compared to caregivers matched for age. These include time for turn in the <70 year olds, total iTUG time in the 70-79 year olds and sit to stand time, walk time, total time to complete iTUG and turning velocity for the >80 year olds.

Declaration of Interests: JMW has consulted with THETAmetrix, the company from which the sensor was purchased. SRN declares no conflicts of interest.

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Table 1. Definition of the Variable Used in this Study.

iTUG Variables	Definition
Standing Acc (m/s/s)	Peak acceleration of the most vertical axis of the accelerometer (meters per second per second)
Sit2stand time (s)	Duration of time taken to complete the sit to stand period (seconds)
Time Walk 1 (s)	Duration of time taken to complete the first walk period (seconds)
ACStepWalk1	Regularity of steps in the first walk period as a correlation
ACStrideWalk1	Regularity of strides in the first walk period as a correlation
RatioWalk1	Symmetry of gait determined by step and stride ratio
Turning Vel1 (°/s)	Peak velocity of the first turning period (degrees per second)
Time for turn (s)	Duration of time taken to complete the first turn (seconds)
Time Walk 2 (s)	Duration of time taken to complete the second walk period (seconds)
ACStepWalk2	Regularity of steps in the second walk period as a correlation
ACStrideWalk2	Regularity of strides in the second walk period as a correlation
RatioWalk2	Symmetry of gait determined by step and stride ratio
Turning Vel2 (°/s)	Peak velocity of the first turning period (degrees per second)
Total Time (s)	Duration of time taken to complete the iTUG (seconds)

Table 2. The Distribution of Gender Across the Age Groups.

	Caregiver		PWD	
<70 years old	Males	Females	Males	Females
Number	4	31	10	4
Age range (years)	67.0 – 69.1	43.3 – 69.0	59.5 - 69.4	59.0 – 68.7
70-79 years old	Males	Females	Males	Females
Number	6	19	18	12
Age range (years)	73.2 – 78.9	70.4 – 79.9	70.6 – 79.8	70.5 – 79.8
80+ years old	Males	Females	Males	Females
Number	8	15	22	17
Age range (years)	82.2 – 88.0	80.0 – 96.0	80.1 – 97.5	80.0 – 90.5

Abbreviations: PWD; People with Dementia

Table 3. Comparison of iTUG Data for Under 70 year old Caregivers and PWD.

<70 year old group	Caregivers (n = 35)		PWD (n = 14)			
	Median	IQR	Median	IQR	P-value	Effect size
Age (years)	63.1	11.10	62.50	8.57	0.188	0.521
Standing Acc[b] (m/s/s)	-2.05	0.73	-1.73	0.50	0.009	0.837
Sit2stand time (s)	1.62	0.54	1.90	0.40	0.209	0.378
Time Walk 1 (s)	2.60	0.67	3.02	2.19	0.068	0.769
ACStepWalk1	0.81	0.29	0.75	0.46	0.790	0.074
ACStrideWalk1	0.77	0.26	0.58	0.60	0.302	0.551
RatioWalk1[b]	1.04	0.27	1.26	1.13	0.030	0.975
Turning Vel1 (^{o}/s)	2.32	0.57	2.11	1.00	0.198	0.447
Time for turn[a] (s)	2.06	0.48	2.46	0.75	0.001	0.698
Time Walk 2[b] (s)	2.10	0.89	2.67	2.85	0.050	0.839
ACStepWalk2	0.87	0.29	0.52	0.59	0.030	0.797
ACStrideWalk2	0.75	0.44	0.66	0.72	0.954	0.122
RatioWalk2	1.05	0.29	0.93	0.83	0.129	0.450
Turning Vel2 (^{o}/s)	2.84	0.97	2.43	1.53	0.324	0.338
Total Time[b] (s)	12.00	2.21	15.41	8.30	0.016	0.807

Abbreviations: PWD; People with Dementia, ACStepWalk; Step Regularity, ACStrideWalk; Stride regularity, RatioWalk; Gait Symmetry, Vel; Velocity

[a] Denotes statistical significance, $P < 0.004$, [b] Denotes large effect size, $d > 0.8$.

Table 4. Comparison of iTUG Data for 70-79 year old Caregivers and PWD.

70-79 years old group	Caregivers (n = 25)		PWD (n = 31)			
	Median	IQR	Median	IQR	P-value	Effect size
Age (years)	74.15	4.50	75.60	4.70	0.116	0.197
Standing Acc (m/s/s)	-1.75	1.29	-1.63	1.01	0.423	0.076
Sit2stand time (s)	1.81	0.70	2.06	0.92	0.098	0.573
Time Walk 1 (s)	3.17	1.33	3.81	2.25	0.053	0.551
ACStepWalk1	0.70	0.39	0.62	0.45	0.176	0.431
ACStrideWalk1	0.72	0.37	0.61	0.42	0.247	0.313
RatioWalk1	1.03	0.37	1.04	0.63	0.487	0.271
Turning Vel1 (^{o}/s)	2.25	0.93	1.91	0.95	0.233	0.270
Time for turn (s)	2.19	0.68	2.48	0.79	0.011	0.775
Time Walk 2 (s)	2.65	1.41	3.75	2.03	0.021	0.667
ACStepWalk2	0.72	0.32	0.61	0.44	0.498	0.269
ACStrideWalk2	0.64	0.52	0.66	0.28	0.545	0.109
RatioWalk2	0.96	0.47	1.03	0.50	0.957	0.150
Turning Vel2 (^{o}/s)	2.35	0.84	2.20	0.92	0.144	0.293
Total Time[a] (s)	13.62	3.98	16.53	5.84	0.002	0.741

Abbreviations: PWD; People with Dementia, ACStepWalk; Step Regularity, ACStrideWalk; Stride regularity, RatioWalk; Gait Symmetry, Vel; Velocity

[a] Denotes statistical significance, $P < 0.004$, [b] Denotes large effect size, $d > 0.8$.

Table 5. Comparison of iTUG Data for 80+ year old Caregivers and PWD.

80+ years old group	Caregivers (n = 23)		PWD (n = 39)			
	Median	IQR	Median	IQR	P-value	Effect size
Age (years)	83.20	4.53	84.30	4.40	0.221	0.160
Standing Acc (m/s/s)	-1.52	0.97	-1.57	0.62	0.889	0.029
Sit2stand time[ab] (s)	1.68	0.81	2.22	0.70	0.001	0.757
Time Walk 1[ab] (s)	3.17	2.01	4.44	2.48	0.001	0.847
ACStepWalk1	0.63	0.44	0.58	0.41	0.565	0.157
ACStrideWalk1	0.64	0.44	0.71	0.48	0.780	0.075
RatioWalk1	1.00	0.71	0.95	0.24	0.675	0.095
Turning Vel1[ab] (^{o}/s)	2.18	0.61	1.71	0.47	0.001	1.010
Time for turn (s)	2.41	0.78	2.79	0.73	0.014	0.648
Time Walk 2[ab] (s)	2.44	1.07	4.16	3.94	<0.001	1.122
ACStepWalk2[b]	0.73	0.36	0.74	0.50	0.060	0.803
ACStrideWalk2	0.83	0.24	0.52	0.59	0.419	0.238
RatioWalk2	1.05	0.27	0.96	0.35	0.087	0.075
Turning Vel2[ab] (^{o}/s)	2.54	0.73	1.71	0.57	<0.001	1.081
Total Time[ab] (s)	13.65	4.94	18.72	7.84	<0.001	1.352

Abbreviations: PWD; People with Dementia, ACStepWalk; Step Regularity, ACStrideWalk; Stride regularity, RatioWalk; Gait Symmetry, Vel; Velocity

[a] Denotes statistical significance, $P < 0.004$, [b] Denotes large effect size, $d > 0.8$.

Table 6. Multivariate Regression Models, Incorporating Age, Gender and Dementia Diagnosis (yes/no).

	Age		Age+ Gender		Age+ Gender+ Diagnosis	
	Adj R^2	*p*	Adj R^2	*p*	Adj R^2	*p*
Standing Acc	0.014	0.070	0.010	0.172	0.030	0.053
Time S2S[a]	0.076	<0.001	0.070	0.002	0.127	<0.001
Time Walk1[a]	0.111	<0.001	0.134	<0.001	0.278	<0.001
ACStepWalk1	0.021	0.036	0.016	0.100	0.017	0.128
ACStrideWalk1	0.003	0.484	0.007	0.650	0.008	0.245
RatioWalk1	0.001	0.298	0.004	0.492	0.022	0.089
Turn Vel1[a]	0.112	<0.001	0.127	<0.001	0.210	<0.001
Time for turn[a]	0.066	0.001	0.066	0.002	0.154	<0.001
Time Walk2[a]	0.083	<0.001	0.082	0.001	0.260	<0.001
ACStepWalk2[a]	0.010	0.105	0.006	0.229	0.067	0.003
ACStrideWalk2	0.002	0.411	0.008	0.711	0.010	0.717
RatioWalk2	0.009	0.122	0.013	0.131	0.021	0.096
Turn Vel2[a]	0.234	<0.001	0.230	<0.001	0.278	<0.001
Total Time iTUG[a]	0.102	<0.001	0.099	<0.001	0.316	<0.001

Abbreviations: ACStepWalk; Step Regularity, ACStrideWalk; Stride regularity, RatioWalk; Gait Symmetry, Vel; Velocity, Adj; Adjusted

[a] Denotes statistical significance, $P < 0.004$