

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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1 **Title**

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

5 **Abstract**

6 **Introduction**

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

14 **Methods**

15 Eight-three community dwelling older PWD and their informal caregivers were recruited for this
16 cross sectional, observational study. Participants were grouped by age; <70 years, 70-79 years and
17 80+ years old. Participants wore an inertial sensor while performing the iTUG in their home. The
18 performance of the sub-elements sit to stand, walking and turning were captured through an
19 algorithm converting accelerations and velocities into performance metrics such as duration and
20 peak velocity. Performance for PWD were compared to caregivers for each age matched group and
21 multiple regression models incorporating age, gender and presence or absence of dementia were
22 computed.

23 **Results**

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

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

31 **Conclusions**

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

34 **Key words**

35 Inertial sensor, aging, dementia, balance, motor performance, [timed up and go](#)

37 **INTRODUCTION**

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

44 The risk of falls is higher among subgroups of the older population. The risk of falls increases
45 with age³ and is different between men and women; women fall more often than men but men have
46 more fatal falls.¹ Another risk factor for falls is dementia; a degenerative neurological disease
47 characterised by a chronic, global, and non-reversible loss of cognitive functioning.⁸ Estimates
48 suggest that 46.8 million people had dementia in 2015 and that this figure will rise to 131.5 million
49 [worldwide](#) by 2050.⁹ People with dementia (PWD) are more than twice as likely to fall and twice as
50 likely to experience injurious falls compared to their cognitively intact peers.^{10,11} In addition, PWD
51 are more likely to experience adverse health outcomes after injurious falls during their hospital stay
52 and after discharge such as hospital readmission, institutionalisation, and mortality.^{12,13,14}

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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 through 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.

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3 **80 METHODS**

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6 81 This cross section observational study used baseline data collected during the TACIT trial
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8 82 (NTC02864056), a randomized controlled trial to test the effects of Tai Chi on postural balance and
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10 83 falls in PWD and their informal caregivers.²⁹ This study was approved by the West of Scotland
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12 84 Research Ethics Committee 4 (reference: 16/WS/0139 and the Health Research Authority (IRAS
13
14 85 project ID: 209193).

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18 **86 Participants**

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20 87 Eighty-three persons with dementia and their informal caregiver were recruited from NHS
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22 88 databases, memory clinics, local charities and through self-referral from across the South of England.
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24 89 As this study used baseline data from the TACIT trial, inclusion criteria reflected recruitment for the
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26 90 TACIT trial. Caregivers needed to be living with the person with dementia or able to visit at least
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28 91 twice a week, able to participate in standing Tai Chi, and be able to commit to supporting the PWD in
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30 92 data collection and in Tai Chi weekly classes and home practice. Exclusion criteria included those
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32 93 caregivers with severe sensory impairment or lacked mental capacity to provide informed consent.
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34 94 PWD were included if they were aged 18 or more; lived at home; had a diagnosis of dementia
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36 95 (indicated on their medical record held by the national health service or general practitioner) and
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38 96 willing and able to complete standing Tai Chi (as part of the TACIT trial). PWD were excluded if they
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40 97 lived in a long term residential care facility; were in receipt of palliative care; scored ≤ 9 on the Mini-
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42 98 Addenbrooke's Cognitive Evaluation (M-ACE);³⁰ had Lewy body dementia or dementia with
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44 99 Parkinson's Disease; severe sensory impairment; were currently under the care of or had been
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46 100 referred to a falls clinic for assessment, currently attending a balance exercise program (e.g. Otago
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48 101 classes), or lacked mental capacity to provide informed consent. In addition participants were
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50 102 excluded if they had completed Tai Chi or similar exercise (yoga, Qi gong, or Pilates) once a week or
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52 103 more within six months of the commencement of the study.
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104 The sample size was based on that used for the Tacit trial.²⁹ This was to recruit a sample of
1 120, powered for a difference of 4 seconds in total time to complete TUG, with a standard deviation
2 105 of 0.38, a correlation of 0.7 and a 2-sided 5% significance level and 90% power. While the recruited
3 106 sample was below target at 83 PWD and their informal caregivers, we obtained smaller standard
4 107 deviations than estimated for the TUG and the estimated smallest detectable change of a value of 4
5 108 was outside the 95% confidence interval (-2,17, 3.81) between the trial arms, suggesting that the
6 109 testing on the TUG was adequately powered.
7 110

111 **Instrumented Timed Up and Go test**

112 Data were collected by a single investigator trained in the use of the iTUG during a visit at the PWD
113 and caregiver's home. Each performed a standardized iTUG once the sensor was placed on their low
114 back: rising for a chair, walking 3 meters to a mark on the floor, turning, then walking back to the
115 chair, and returning to sitting. Participants were free to choose turning direction and a pragmatic
116 approach to the particular chair available within the individuals' home was used. Participants were
117 encouraged to not use arm rests and were permitted to use their 'usual' walking aid, however only
118 one person in the older PWD group used a cane during testing. Previous studies have demonstrated
119 excellent reliability for total time to complete Timed-Up and Go and a range of minimal detectable
120 change (MDC) values across a variety of clinical presentations, ranging from ICC=0.81, MDC=4.4s for
121 persons with early Dementia³¹ to ICC=0.97, MDC 1.1s for older adults with osteoarthritis.³²

122 A trunk mounted inertial measurement unit (Balance Sensor, THETAmatrix, Portsmouth, UK)
123 was mounted over the middle of the individuals low back, reinforced with an elasticated strap. The
124 Inertial Measurement Unit (IMU) incorporates a triaxial accelerometer and triaxial gyroscope
125 providing linear accelerations and rotational velocities at 30Hz. Excellent reliability of the IMU has
126 been previously reported.³³ Data were exported to matlab for feature extraction. An automated
127 algorithm was used to detect the sub-phases of the iTUG, as has been previously described.²⁸ Data
128 were filtered at 6Hz to remove high frequency noise. Temporal events and sub-phases were
129 identified by local maxima/minima detection and zero crossing points from the respective

130 acceleration and gyroscope traces. In addition, walking periods of the iTUG were used to compute
131 measures of regularity (ACstep, ACstride) and symmetry (ratio) using autocorrelation methods.³⁴ The
132 variables investigated in this study are presented in table 1.

133 **Statistical analysis**

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

146 **RESULTS**

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

151 Age group categorization and statistical results for comparison between caregivers and PWD
152 are presented in tables 3-5. The younger age group comparisons (table 3) demonstrated that,
153 following Bonferroni correction, only time taken to complete the turn was significantly different
154 between the groups. However large effect sizes ($d > 0.8$), which in contrast to statistical testing are
155 used to quantify the magnitude of the observed effect, were observed between the two groups for

156 standing acceleration, time to complete walking phase 2, total TUG time and gait asymmetry during
157 walk phase 1. The middle age group comparisons (table 4) demonstrated that PWD took significantly
158 longer to complete the total iTUG. The older age group comparisons (table 5) demonstrated that
159 PWD took significantly longer to complete sit-to-stand, both walking phases, total iTUG and turning
160 velocity was lower. Large effect sizes were determined for time to complete both walking phases
161 and the total iTUG in addition to turning velocity and step regularity during walk phase 2.

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

173 Discussion

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

180 Differences between PWD and caregivers in the youngest age group (<70 years of age) were
181 demonstrated for time for turn, and may offer early indications of deterioration in function. PWD
182 took around 20% longer (0.4 seconds) to complete the turn than caregivers of a similar age. Turning
183 has been identified as a complex task requiring a coordinated sequence of axial rotations of multiple
184 body parts,³⁵ all of which may require longer processing in PWD. In addition, large effect sizes were
185 identified for standing acceleration, gait symmetry, time to walk phase 2 and total time to complete
186 iTUG. These did not meet the stringent criteria for Bonferroni correction, however the magnitude of
187 actual difference was similar (around 20%). Total time to complete was quite variable in PWD
188 (coefficient of variation (calculated by dividing the mean by the standard deviation) = 54%),
189 suggesting great variability in performance of the whole iTUG across the group. In addition the
190 observed difference between the groups was 3.4s, slightly below that identified as the MDC³¹.
191 Standing acceleration was much less variable, while still demonstrating a large effect size between
192 groups, suggesting this could be used as a key performance indicator in younger PWD. Sit-to-stand
193 acceleration may represent early deficits in power from the lower limbs.¹⁷

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

205 The divergence in metrics is much clearer in the older group (80+ years of age). Walking
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2 206 durations, turning velocity and sit to stand time were prolonged suggesting a strong down gearing of
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4 207 movement velocity with actual differences of around 25%. This suggests a loss of around a quarter of
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7 208 these higher functions. This is corroborated by effect size analysis where large effect sizes were
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9 209 determined for the above variables, **except** sit to stand time. There seems to be little difference in
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11 210 these values for the caregivers as they age, but a sharper drop in performance in PWD noted
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13 211 between the 70 and 80+ year old group. It is possible that this is due to a progression in dementia
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15 212 impacting on performance, illustrating that as the disease progresses the performance declines
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17 213 resulting in the divergence observed after 80 years of age. However, despite our previous study
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19 214 demonstrating that walk time and TUG time were correlated with dementia disease severity (as
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21 215 measured using the M-ACE), the strength of the relationship was weak at 0.25-0.28 and non-existent
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23 216 for other sub-phases of the iTUG.²⁸ This throws into question the mechanism behind such marked
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25 217 deficits observed in the older age group. The current findings illustrate that it is not simply age, and
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27 218 our previous findings illustrate it is not simply disease severity that reduces performance on the
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29 219 iTUG and its subtasks. This is corroborated further by our multivariate models that showed an
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31 220 increased variance explained by adding dementia diagnosis to age as the predictor variables. This
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33 221 suggests that a more complex multifactorial explanation is required. It is possible that fear of falling
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35 222 is important as this correlated with iTUG in PWD, explaining up to 20% of total time to complete
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37 223 iTUG.²⁸ However perhaps deconditioning plays an important role also,^{39,40,41} where activity down-
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39 224 regulation results in a reduction in physical capacity.

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

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

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

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

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257 **CONCLUSION**

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3 258 This study demonstrated significant differences in performance of specific elements of the iTUG in
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5 259 PWD compared to caregivers matched for age. These include time for turn in the <70 year olds, total
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7 260 iTUG time in the 70-79 year olds and sit to stand time, walk time, total time to complete iTUG and
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9 261 turning velocity for the >80 year olds.
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392 **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)

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

	Caregiver		PWD	
<i><70 years old</i>	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
<i>70-79 years old</i>	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
<i>80+ years old</i>	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

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397 **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 (°/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 (°/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.

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400 **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 (°/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 (°/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, $d > 0.8$.

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403 **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} (°/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} (°/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.

406 **Table 6. Multivariate Regression Models, Incorporating Age, Gender and Dementia Diagnosis**

407 **(yes/no).**

	Age		Age+ Gender		Age+ Gender+ Diagnosis	
	Adj R ²	<i>p</i>	Adj R ²	<i>p</i>	Adj R ²	<i>p</i>
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

42 Abbreviations: ACStepWalk; Step Regularity, ACStrideWalk; Stride regularity, RatioWalk; Gait

45 Symmetry, Vel; Velocity, Adj; Adjusted

47 ^a Denotes statistical significance, P < 0.004

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