

**ORIGINAL ARTICLE**

# Validity of Simple Gait-Related Dual-Task Tests in Predicting Falls in Community-Dwelling Older Adults



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**Abstract**

**Objective:** To investigate the predictive validity of simple gait-related dual-task (DT) tests in predicting falls in community-dwelling older adults.

**Design:** A validation cohort study with 6 months' follow-up.

**Setting:** General community.

**Participants:** Independently ambulant community-dwelling adults (N=66) aged  $\geq 65$  years, with normal cognitive function. Sixty-two completed the follow-up. No participants required frames for walking.

**Interventions:** Not applicable.

**Main Outcome Measures:** Occurrence of falls in the follow-up period and performance on primary and secondary tasks of 8 DT tests and 1 triple-task (TT) test.

**Results:** A random forest classification analysis identified the top 5 predictors of a fall as (1) absolute difference in time between the Timed Up & Go (TUG) as a single task (ST) and while carrying a cup; (2) time required to complete the walking task in the TT test; (3 and 4) walking and avoiding a moving obstacle as an ST and while carrying a cup; and (5) performing the TUG while carrying a cup. Separate bivariate logistic regression analyses showed that performance on these tasks was significantly associated with falling ( $P < .01$ ). Despite the random forest analysis being a more robust approach than multivariate logistic regression, it was not clinically useful for predicting falls.

**Conclusions:** This study identified the most important outcome measures in predicting falls using simple DT tests. The results showed that measures of change in performance were not useful in a multivariate model when compared with an "allocated all to falls" rule.

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Many dual-task (DT) tests have been developed in recent years. One important area of DT research is the assessment of falls risk, with poor gait performance in DT conditions predicting falls in older adults living in a variety of settings.<sup>1</sup> Dual tasking is one form of executive functioning, and deterioration in executive functioning has been associated with falling.<sup>2</sup>

In general, slowing down under DT conditions can predict falls in older adults.<sup>1,3</sup> Reviews<sup>1,4</sup> conducted to assess the predictive

validity of DT tests for falls have shown conflicting results. Moreover, DT tests seem to be better in predicting falls in frailer older adults.<sup>1,5</sup> Studies conducted in the community setting have had conflicting results. Some have shown validity in predicting falls,<sup>2,6-11</sup> some have shown no added value over single-task (ST) tests,<sup>3</sup> and some showed no predictive validity.<sup>12-15</sup> The contradictory results might be explained by the heterogeneity of the tasks used, the outcomes measured, and the duration of falls' follow-up periods.<sup>1,4,16</sup> Furthermore, most of the cognitive tasks used in the tests lack ecologic validity.<sup>17</sup>

Research in the area of dual tasking has suffered from a scarcity of assessment of secondary task performance.<sup>4</sup> This is a problem if older adults vary in which tasks they prioritize

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under DT conditions. Some participants might concentrate on gait and potentially avoid falls. Others might prioritize the secondary task, which might increase the falls risk. The use of complex methods to measure gait or balance performance, such as with force platforms and electronic walkways,<sup>9,14,15</sup> has been a feature of most studies, making these difficult to perform in the clinical setting. Most studies<sup>2,8,15</sup> have assessed raw ST or DT performance, or both, as a predictor of falls. However, raw performance (eg, walking speed) does not provide a measure of the specific impact of dual tasking (since most of the variance in walking under DT conditions is accounted for by walking under ST conditions). The use of a measure of proportionate change in task performance is recommended to account for differences in baseline ST performance.<sup>18</sup> Unfortunately, in the community setting, only Yamada et al<sup>10</sup> have used such a measure.

In previous studies,<sup>19,20</sup> we have investigated the feasibility and reliability of a variety of DT combinations in community-dwelling older adults, and a set of 9 tests was identified. The primary aim of this study was to assess the predictive validity of these simple gait-related DT and triple-task (TT) tests in predicting falls in community-dwelling older adults. Uniquely, this study has performed a comprehensive assessment of the predictive validity of several clinically feasible DT tests, by measuring performance on both primary and secondary tasks and considering both the absolute and proportionate differences in performance to identify which tests and which measures would be the best predictors of falls in community-dwelling older adults.

## Methods

### Participants

A convenience sample was recruited through a community falls prevention program and friends and family of staff at a university. To be eligible to take part in the study, participants had to be 65 years or older, community dwelling, able to speak and understand English, able to travel to the assessment laboratory, have a Mini-Mental State Examination (MMSE) score of  $\geq 24$ , and be able to maintain their feet together and adopt the semitandem stance of the 4-test balance scale for 10 seconds.<sup>21</sup> Exclusion criteria included the use of walking frames and uncorrected visual or hearing impairments.

#### List of abbreviations:

CI	confidence interval
DT	dual task
EXIT-15	abbreviated Executive Interview
FES-I	Falls Efficacy Scale—International
HADS	Hospital Anxiety and Depression Scale
IQR	interquartile range
MMSE	Mini-Mental State Examination
OOB	out-of-bag
OR	odds ratio
POMA	Performance Oriented Mobility Assessment
RF	random forest
ST	single task
TT	triple task
TUG	Timed Up & Go

### Ethical approval

Ethical approval for this study was granted by the West of Scotland Research Ethics Committee (reference no., 10/S0701/82) and the ethics committee at the university. The participants were provided with an information sheet explaining the study and asked to sign consent forms.

### Procedures

Participants attended a single data collection session. Sample baseline characteristics were recorded using a self-reported health questionnaire adapted from Greig et al,<sup>22</sup> body mass index, MMSE,<sup>23</sup> 4-test balance scale,<sup>21</sup> abbreviated Executive Interview (EXIT-15),<sup>24</sup> Hospital Anxiety and Depression Scale (HADS),<sup>25</sup> Performance Oriented Mobility Assessment (POMA),<sup>26</sup> and Falls Efficacy Scale—International (FES-I).<sup>27</sup>

Eight DT tests and 1 TT test were used to predict falls. These tests had previously been found reliable in a sample of community-dwelling fallers and nonfallers.<sup>20</sup> These tests were as follows:

1. Straight walking and visuospatial clock task
2. Walking with turns and naming animals
3. Walking with turns and counting backwards in 3s
4. Avoiding stationary obstacles and naming animals
5. Avoiding a moving obstacle and carrying a cup
6. Timed Up & Go (TUG) and carrying a cup
7. Stair descent and naming animals
8. Walking while talking complex<sup>6</sup>
9. Straight walking, visuospatial clock task, and carrying a cup (TT test)

The visuospatial task required deciding whether the 2 hands of an imaginary clock are on the same or different sides of a line drawn between the 12 and 6.<sup>28</sup>

Primary task *walking time* was measured with a stopwatch, and secondary task performance was recorded and assessed as *performance speed* (total answers/second) and *accuracy* (errors/total answers). Participants were instructed to walk at their preferred speed and to perform both tasks as well as they could. A rest period was offered after each test to prevent fatigue. Participants performed the tasks as STs first. Secondary STs were performed in a seated position for 30 seconds, and ST performance was adjusted individually for each task combination to be equivalent to the DT time. The order of the STs and DTs was chosen randomly to avoid performance bias. The cup task was assessed dichotomously as “no spill” or “spill.”

### Follow-up

A 6-month follow-up period was implemented to collect the incidence of falls. Participants were provided with monthly falls' diaries as recommended by the Prevention of Falls Network Europe.<sup>29</sup> These diaries were sent back at the end of each month via prepaid envelopes. A brief telephone interview was conducted in the event of a fall to inquire about the circumstances and consequences of the fall.

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