Association between a history of falls and the ability to multi-task in community-dwelling older people

Hyuma Makizako1, Taketo Furuna2, Hiroyuki Shimada1, Hikaru Ihira2, Mika Kimura3, Eiichi Uchiyama1 and Lars I.E. Oddsson4

1Section for Health Promotion, Department of Health and Medical Care, Center for Development of Advanced Medicine for Dementia, National Center for Geriatrics and Gerontology, Aichi, Japan, 2School of Health Sciences, Sapporo Medical University, Sapporo, Japan, 3International Life Sciences Institute Japan, Tokyo, Japan, 4Sister Kenny Rehabilitation Institute, Sister Kenny Research Center, Minneapolis, USA

ABSTRACT. Background and aims: Many older people fall when they perform tasks which require increased attention. The aim of this study was to determine differences in reaction times, during simple-, dual- and triple-task conditions requiring differing levels of motor coordination, balance control and cognitive attention, between groups of fallers and non-fallers in community-dwelling older individuals. Methods: The study involved the recruitment of 87 older individuals living at home, 57 women and 30 men aged 75 to 91 years. Reaction times, measured by pushing a handheld button as quickly as possible in response to a visual stimulus, were measured in four conditions: 1) quiet standing (simple-task); 2) counting backward during quiet standing (dual-task with cognitive demand); 3) stepping in place (dual-task with balance demand); and 4) counting backward while stepping in place (triple-task with cognitive and balance demands). Results: Twenty-nine (33.3%) participants had fallen at least once during the past year. There were no statistically significant differences in reaction times between non-fallers and fallers during any of the tasks. Reaction times were significantly longer during the dual- and triple-tasks compared with the simple-task conditions in both groups. The ratio between reaction times during dual-tasks with balance demands (stepping in place) and those in the simple-task condition were significantly related to a history of falls and showed the highest odds ratio (OR 3.16, 95% CI 1.06-9.45, p=0.04). Conclusions: Relative changes in reaction times during a dual-task with balance demands were more sensitive to past falls than those during a dual-task with cognitive demands.


INTRODUCTION

Falls are a major healthcare problem in the growing population of older people in developing countries. Approximately 30% of older adults fall each year (1-3), and falls are the third leading cause of long-term care in those aged 65 and older in Japan (4). Previous studies report that many physiological factors, such as impairment of vision, peripheral sensation, muscle strength, reaction time, cognition, gait and balance, individually and cumulatively increase the risk of falling in older people living in the community (5-7). However, many older adults without an established risk of falling fall in a community setting. These healthy older adults fall when they perform tasks requiring increased attention in complex circumstances (8). Evaluating outcomes based on dual-task paradigms may be useful for identifying the risk of falling in healthy older adults (9), as older adults show worse balance performance during cognitive tasks than young adults (10).

Some studies (11-14) have reported an association between dual-task performance and a greater fall risk in older adults, although Bootsma-van der Wiel et al. (15) reported that dual-task performance was not a better predictor for incident falls than single-task performance in 85-year-old adults. Other studies (13, 14) reporting the relationship between dual-task performance and a history of falling in a community-based design have included fallers with poorer abilities in simple physical performance tests (e.g., muscle...
strength, usual walking speed) and disadvantaged characteristics (e.g., older age) in comparison with non-fallers. More sensitive measures of impaired multi-task execution may better test the characteristics needed to identify the relationship between poor multi-task performance and falling in healthy elderly adults.

The purpose of this study was to determine sensitive measures for identifying older adults with a potential risk of falling in a healthy older population. Attention capacity by means of reaction times (RTs) during simple-, dual- and triple-task conditions was used to examine the differences between older groups of fallers and non-fallers living independently in the community. Dual- and triple-task conditions require balance demands and cognitive attention in available task conditions in community-based design among older adults. Our hypotheses were that changes in RTs in multi-task conditions would relate to a history of falling in community-dwelling elderly Japanese showing similar physical performance and that RTs in triple-task conditions combining cognitive and balance tasks would show a closer relationship with a history of falling than RTs for dual-tasks among independently living older adults. To investigate these hypotheses, we used the ratio of multi-task to simple-task RTs, which may reveal differences between tasks.

METHODS

Participants

The present report is based on data from the “WHITE project” (Winter Time, Health Improvement Tactics for the Elderly), an intervention study on health promotion for older individuals in Hokkaido, Japan, using videos and texts developed by the International Life Sciences Institute, Japan. Data for this study also come from three communities (Hidaka town, Toyako town and Makkari village) which agreed to join our project. A total of 87 older individuals living at home were recruited to participate in the study: 57 women and 30 men, aged 75 to 91 (mean age 80.3 yrs). One hundred and forty-three volunteers responded to an advertisement for the “WHITE project” in a local newspaper and at local senior centers. Criteria for inclusion were ages 75 years or older and no serious neurological or musculoskeletal diagnoses, such as history of Parkinson’s disease. In this study, all participants were living independently in the community and showed a full score (=5) on the five-item subscale of Instrumental Self-Maintenance of the Tokyo Metropolitan Institute of Gerontology-Index of Competence (TMIG-IC) (16). The reliability and validity of the TMIG-IC have been confirmed in a large sample (16). Subjects were excluded if they reported serious visual or balance impairment which made them unable to step in place without support. The ethics committee of the Sapporo Medical University approved the project and this study. All participants provided written informed consent.

Cognitive function and history of falls

Participants were assessed for cognitive function with the Mental Status Questionnaire (MSQ) (17), which contains ten objective items which are summed to screen for cognitive disorders. The MSQ interview confirmed whether each participant could understand our test protocols without serious cognitive impairment. Participants reported their history of falling in the previous 12 months. A fall was defined as ‘an unintentional change in position resulting in coming to rest at a lower level or on the ground’ (18).

Strength, balance and walking tests

The participants performed the knee-extension strength, one-leg standing and five-meter walking tests. Knee-extension strength was assessed on a portable hand-held dynamometer (μTas F-1, ANIMA Corp). One-leg standing is a commonly used balance assessment of postural stability. Participants were asked to stand on their preferred leg as long as possible with their arms hanging down and with their eyes open. One-leg standing balance was measured as the time (0-120 sec) participants could stand on one leg. In this study, participants were asked to walk along a straight, level path at their ‘maximal walking speed.’ Participants were instructed to walk an 11-meter course at maximal walking pace. In the 11-meter course, two markers were used to indicate the start and end of the 5-meter path, a 3-meter approach was allowed before reaching the start marker and a 3 meters of space was provided after the end marker of the 5-meter path to ensure maximal walking pace throughout the task. The time taken to complete the measured 5-meter walk, measured in seconds, was the subject’s score.

Apparatus and procedure

Each participant’s RT was measured in four conditions which included dual- and triple-tasks. RTs measured by pushing a handheld button as quickly as possible in response to a visual stimulus (a bright red light), were measured in four conditions: 1) quiet standing (simple-task); 2) simple counting backward (i.e., in ones, e.g., “100-99-98-97-96-95”) during quiet standing (dual-task with cognitive demands); 3) stepping in place (dual-task with balance demands); 4) simple counting backward while stepping in place (triple-task with cognitive and balance demands). First, participants’ RTs were measured with quiet standing as the simple-task condition. RTs were defined as the temporal interval between the presentation of a visual stimulus and the onset of a pushing response. In the simple-task condition, participants were asked to push a handheld button as quickly as possible following the presentation of a red light stimulus, composed of seven small lights (each with a diameter of 5 mm). The experimenter confirmed that participants stood safely and quietly, and then issued the verbal command “ready” as a starting signal to them before RT measurement. A start-