ASSOCIATION OF EXECUTIVE FUNCTION IMPAIRMENT, HISTORY OF FALLS AND PHYSICAL PERFORMANCE IN OLDER ADULTS: A CROSS-SECTIONAL POPULATION-BASED STUDY IN EASTERN FRANCE

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Abstract: Objective: To estimate: 1) the association between executive function (EF) impairment and falls; and 2) the association of EF impairment on tests of physical function used in the evaluation of fall risk. Design: Cross-sectional study. Setting: Thirteen health examination centres in Eastern France. Participants: Four thousand four hundred and eighty one community-dwelling older adults without dementia aged 65 to 97 years (mean age 71.8±5.4, women 47.6%). Measurements: Participants underwent a comprehensive medical assessment that included evaluations of EF using the Clock Drawing Test and of physical performance using the Timed Up & Go Test (TUG). Analysis used multivariable modified Poisson regression to evaluate the association between impaired EF and each of the fall outcomes (any fall, recurrent falls, fall-related injuries). Multivariable linear regression was used to evaluate the association between EF impairment and performance on the TUG and grip strength. Results: EF impairment, assessed using the clock drawing test, was present in 24.9% of participants. EF impairment was independently associated with an increased risk of any fall (RR=1.13, 95% CI (1.03, 1.25)) and major soft tissue fall-related injury (RR= 2.42, 95% CI (1.47, 4.00)). Additionally, EF impairment was associated with worse performance on the TUG (p<0.0001). Conclusions: EF impairment among older adults without dementia was highly prevalent and was independently associated with an increased risk for falls, fall-related injuries and with decreased physical function. The use of the Clock Drawing Test is an easy to administer measure of EF that can be used routinely in comprehensive fall risk evaluations.

Key words: Accidental falls, cognitive impairment, risk factors.

Introduction

Falls among older adults are a major public health concern (1). An emerging area of falls research is the role of impaired cognition to disturb the higher levels of balance and gait control. Postural stability is a complex process involving the coordination of motor and sensory systems through higher order neurological processes, in particular executive function (EF) (2, 3). EF is required for planning movements, divided attention and responding to changes within the environment (2).

Fall prevention guidelines give limited direction for the assessment of cognition as a fall risk factor (4). A recent systematic review found global measures of cognition were poor predictors of falls, though EF impairment, identified through a comprehensive neuropsychological assessment, was consistently associated with an increased risk (5). Considering the practical limitations or lack of access to a comprehensive neuropsychological assessment, there is a need to evaluate the utility of other tests of EF for routine use in a falls clinic setting (6). The Clock Drawing Test is one measure that is already widely used in clinical practice and has demonstrated reliability and diagnostic validity, ease of administration and scoring, and evaluates EF (7-9).

The objectives of this study were to estimate: 1) the association between EF impairment and falls, and 2) the association of EF impairment on tests of physical function used in the evaluation of fall risk.

Methods

Study Population

Data were collected July 2008 - December 2010 from a medical examination at the health examination centers for the French health insurance of 13 towns in eastern France. A total of 5097 people participated in the assessments. Exclusion criteria were: age below 65 years, inability to understand and speak French, history of an acute medical illness during the previous month, diagnosis of dementia, and inability to walk 6 meters unassisted. For the present analyses, people residing in institutional settings were excluded. Additionally, 29 participants were excluded who reported a fall-related closed head injury in the year before the assessment as this could adversely affect cognitive status post-fall. In final, data from 4481 participants (88% of those assessed) were used in the analyses of this study. The local ethics board of Lyon approved the original study on which this secondary data analysis was performed.
Clinical Assessment
All participants underwent a standardized comprehensive medical examination. The use of psychoactive drugs and the number of drugs taken each day were recorded. The Body Mass Index (BMI, kg/m²) was calculated based on anthropometric measurements of weight in kilograms (kg) and height in meters. Distance binocular vision was measured at 5 m with a Snellen letter test chart (10). Cognitive function was evaluated using the Cognitive Disorders Examination (Codex) test; the test includes the Five Word Recall Test and the Clock Drawing Test (11). Depressive symptoms were evaluated using the 4-item Geriatric Depression Scale (mini-GDS), where a score >1 indicates a more detailed assessment of depressive symptoms is warranted (12). Basic mobility was assessed using the Timed Up & Go Test (TUGT), recorded as the time in seconds required for a person to arise from a chair, walk 3 meters, turn around to walk back to the same chair and sit down (13). The maximal isometric voluntary contraction for grip strength was measured in the dominant hand using a computerized hydraulic dynamometer (Martin Vigimeter, Medizin Technik, Tuttingen, Germany). Self-reported history of falls in the previous 12 months was obtained using a standardized questionnaire. The questions explored the number of falls, presence and type of fall-related injuries, circumstances/activity at the time of the fall, ability to get up after the fall, and location of fall. Fear of falling was recorded using the question, “Are you afraid of falling?”

Exposure
The Clock Drawing Test challenges executive control and visuospatial functions. Participants were given a blank sheet of paper and then asked to draw a clock face, place the numbers around the clock and then draw the hands to indicate a specified time given by the examiner. Executive control functions involved in the CDT include complex goal directed of goal selection, planning, motor sequencing, selective attention and monitoring of the task (9). The exposure of interest in the study was impairment on the Clock Drawing Test from the Codex and was used as a marker of executive function problems. Test errors were categorized as present or absent in the execution of drawing the face of the clock and/or in the hands of the clock. Impaired EF was defined as the presence of one or more errors.

Outcomes
The primary outcome of interest was a history of falls in the previous 12 months. A “fall” was defined as an event resulting in a person coming to rest unintentionally on the ground or at another lower level, not as the result of a major intrinsic event or an overwhelming hazard. Recurrent falls was defined as two or more falls in the previous 12 months. The types of fall-related injury evaluated were fractures and major soft tissue lesions (i.e. hematoma or laceration).

Data Analysis
Baseline characteristics were summarized using either means and standard deviations, or frequencies and percentages, and compared using t-tests and Chi-square tests as appropriate. Information on falls was summarized descriptively.

A univariate analysis between impaired EF and each of the dependent fall outcome variables (any fall, recurrent falls, fall injury), each a dichotomous variable, was performed to generate unadjusted relative risk (RR) estimates and 95% confidence intervals (CI). In the adjusted analysis, variables selected for confounding control were based on clinical significance and previously identified fall risk factors (age, sex, number of prescription medications (≥ 4), fear of falling and depression) to generate the most parsimonious model. A modified Poisson regression model was then applied to directly obtain adjusted relative risk values (14).

In the second analytic evaluation, a univariate analysis between impaired EF and the Timed Up & Go Test (TUGT) was first conducted using simple linear regression. In the adjusted analysis, variables selected for confounding control were age, sex, history of falls, depression and mobility aid use. The statistical analyses were conducted using SAS software version 9.2 (SAS Institute, Inc., Cary, NC).

Results
Characteristics of the sample are presented in Table 1. Using the Clock Drawing Test, 24.9%, 95%CI (23.6 – 26.2) of the sample was identified as having impaired EF. The prevalence of a falls history was 28.1% for the whole sample, but 26.7% and 35.2% among those without and with abnormal EF respectively (p<0.0001). People with impaired EF also reported a greater number of single falls, 23.5% versus 18.8%, and recurrent falls, 11.8 % vs. 7.8% (p<0.0001). Among all participants, the majority of falls occurred outside the home and there was no difference on EF impairment. In both cognitive status groups, the most common activity reported at the time of falling was walking, but the percentage was significantly greater in the EF impaired group at 85.5% compared to 77.8% (p<0.0001). A fear of falling was reported by 30.5% of the people with impaired EF compared to 21.7% (p<0.0001) for those without impairment. Fall-related fractures occurred in 14.9% of the sample, though this did not differ by cognitive status group. Major soft tissue lesions occurred in 4.6% of the sample and were more common among people with EF impairment, 7.9% versus 3.1% (p<0.0005). The inability to get up after a fall occurred in 19.2% of the whole sample and was also more common in people with EF impairment, 23.1% versus 17.5% (p<0.022).

Impaired EF was independently associated with any fall in the adjusted regression analysis with RR=1.13, 95%CI (1.03, 1.25). (Table 2) While the relative risk estimate also indicated a positive association between impaired EF and recurrent falls, it was not statistically significant. EF impairment was