Original Article

Beyond balance and mobility, contributions of cognitive function to falls in older adults with cardiovascular disease

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Abstract

Objectives: Older adults with cardiovascular disease (CVD) are at risk for cognitive impairment. Cognitive function is associated with falls in older adults however it is unknown if a relationship exists between cognitive function and falls in CVD. The aim of this study was to examine the contributions of cognitive function on falls in older adults with CVD. Methods: A secondary analysis was performed on data from the Health and Retirement Study cohort 2010 (N=3413) of older adults with CVD. Group assignment was based on falls history (yes/no) within the two years prior to the survey. Demographic (age, education, gender, marital status), physical (strength, balance, physical activity, and mobility) and cognitive (immediate and delayed recall, orientation, semantic verbal fluency, numeracy) information was extracted to characterize the sample. Comparisons between groups were completed for all of these variables. Logistic regression was performed to examine associations between each of the cognitive variables and falls while controlling for age, gender, marital status, education, and BMI. Results: Demographic (age, gender, marital status, and education), physical (grip strength, tandem stance time, and gait speed), and cognitive (orientation, immediate and delayed recall) variables differed by falls history (p<0.05). After controlling for confounding, immediate recall was the only significant predictor of falls (OR=1.09, 95% CI=1.01-1.17) (Nagelkerke R²=0.037, χ²=35.14, p<0.05) with correctly classifying 65.9% of cases. Conclusions: In older adults with CVD, cognitive and physical functions are more impaired in those with a falls history. Screening for cognitive function, specifically immediate recall, should be a part of the management of falls in this population.

Keywords: Cardiovascular disease, Cognition, Recall, Falls, Mobility

Introduction

One out of four older adults falls each year, accounting for more than fifty billion dollars in health care costs. Adults with cardiovascular disease (CVD) are reported to have higher odds of falling as compared to those without reported CVD. A link between cognition and falls/falls risk has been reported in the literature. Cognitive function is used in everyday mobility tasks and specifically during goal-directed activities, the initiation of tasks, and while negotiating obstacles within the environment. Older adults with impaired cognition have an increased likelihood of falling than cognitively intact peers, and are at an increased risk for an injurious fall, and institutionalization after falling. Various cognitive processes have been identified as significant predictors of functional decline and falls in older adults. In older adults, impaired cognitive function has been associated with decreased performance in activities of daily living and slower, more impaired gait.

Of particular interest is that despite the possibility of cognitive decline occurring throughout the aging process, the changes in cognition may be more pervasive in those with CVD. The prevalence of cognitive impairments in adults with CVD ranges from 30% to 80% and is dependent on disease type and duration. However, decreased performance on cognitive measures has been reported in older adults with CVD regardless of age and education.

The authors have no conflict of interest.

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Edited by: Dawn Skelton
Accepted 22 August 2019
indicating that cognitive dysfunction may play a more predominant role in those with CVD. Studies in CVD which address falls risk factors have primarily focused either on mobility related factors such as decreased gait speed, impaired balance or the presence of disease associated side effects (e.g. orthostatic hypotension). Although changes in functional mobility provide sufficient evidence of the concern of falls in CVD, a crucial knowledge gap exists in the additional role that cognitive impairment plays on falls, given the prevalence of cognitive decline in older adults with CVD. Determination of the specific cognitive functions that contribute to falls in older adults with CVD is imperative to incorporate appropriate cognitive screening and interventions in this population for reducing falls risk. Therefore, the aim of this study was to first describe the differences in cognitive function in older adults with CVD by falls history. A secondary aim was to examine the influence of specific cognitive processes on falls (yes/no) in older adults with CVD using logistic regression.

Materials and methods

The sample for this cross-sectional study comes from the 2010 wave of the Health and Retirement Study (HRS). HRS is a longitudinal study which surveys a representative sample of approximately 20,000 community dwelling Americans over age 50 every two years. The 2010 wave included participants from 50-110 years of age. A detailed description of the study can be found at: http://hrsonline.isr.umich.edu/. This secondary analysis was approved by the institutional review board of the primary investigator.

Data for the HRS interview was collected between March 2010 through May 2011 through information provided by the respondent or their proxy. Data was included if respondents were aged 65 years+, had a diagnosis of CVD, and did not have Alzheimer’s disease, dementia, diabetes, depression, or history of cancer. Additionally, those with a history of stroke were excluded from the sample to reduce confounding of falls and associated cognitive impairments resulting from cerebrovascular insults. The American Heart Association definition for CVD was used to create the sample population. CVD was defined as any condition affecting the heart and blood vessels and included diagnoses of coronary heart disease, congestive heart failure, hypertension, peripheral artery disease, arrhythmia, or heart valve disorders. Respondents who reported to have a physician diagnosis of heart disease, myocardial infarction, congestive heart failure, arrhythmia, heart valve problems, hypertension, or those who were taking medications for the aforementioned conditions were included in the sample. Respondents who had incomplete demographic, disease, physical function or cognitive information were excluded. The 2010 HRS wave consisted of a total of 22,034 respondents, of which 4051 had CVD and 3413 met inclusion/exclusion criteria for this study.

Demographic data extracted included age, gender, marital status, and education. Other health related variables included the reported frequency of engaging in mild physical activity at least once per week and anthropometric measures for calculation of body mass index (kg/m²). Falls information required respondents or their proxy to account for any falls which occurred in the two years prior to the survey interview. Falls data extracted included incidence (yes/no), number of falls, and whether an injury (yes/no) had occurred from a fall.

Measures of strength, balance, and mobility were extracted to characterize the sample. Grip strength measurement data (dominant hand) was used as a measure of overall strength. Tandem stance time was used as a measure of balance. Considered to be a necessary component of balance in community dwelling older adults, the ability to perform tandem stance has been associated with fall risk. The total amount of time, in seconds that the respondent was able to stand in heel to toe tandem position without support for up to 60 seconds was recorded. Mobility was assessed via gait speed measurement. Gait speed is associated with cognitive function and falls in older adults. In the HRS, gait speed was measured over two trials as the time (in seconds) required to walk an eight-foot distance on level surfaces. The average speed over two trials was calculated and converted to meters per second for analyses.

Cognitive data extracted included assessments of memory (immediate and delayed), orientation, verbal fluency, and numeracy. Memory was measured via immediate and delayed word recall. For immediate word recall (IWR), the interviewer read a randomly assigned list of 10 nouns to the respondent, and asked the respondent to recall as many words as possible from the list in any order immediately afterwards. The number of correctly recalled words was recorded for this task. Delayed word recall (DWR) required respondents to name as many of those original 10 words after a period of 5 minutes had passed and during which the respondent was engaged in other tasks. DWR was scored in the same fashion as IWR. Orientation was assessed by the respondent being able to correctly recall the week, month, day, and year. Scores ranged from ‘0’ indicating that no correct responses were provided to ‘4’ indicating that all orientation items were correctly answered. A verbal fluency task was used as a measure of executive function as it requires the use of strategic search, set-shifting and semantic memory for task completion. In the semantic verbal fluency test respondents were required to name as many animals as possible in 60 seconds with the total number of named animals to comprise the score. Numeracy was measured with the serial sevens subtraction test (SST) which is a measure of concentration and attention. For the SST respondents were required to subtract 7 from 100, then from 93 and so on for a series of 5 sequential subtractions. All numerical responses were recorded and respondents were not corrected during this process. The number of numerically correct subtractions (even after error) are summed to produce the respondent’s
Cognition falls in cardiovascular disease

To detect differences in cognitive and physical function of the CVD sample by falls history, two groups were created based on reporting a history of falls (yes/no) within the two years prior to the survey (Falls Group; No Falls Group). Demographics were first described for the whole sample and then for each group. Characteristics were then compared by group using ANOVA for continuous variables and χ² for dichotomous variables. Multivariable logistic regression analyses were performed to examine the odds ratio (OR) with a 95% confidence interval (95% CI) for falling in older adults with CVD by cognitive performance. An OR greater than 1 is indicative of an increased likelihood of falling. The cognitive predictor variables included: semantic verbal fluency, IWR, DWR, numeracy, and orientation. The outcome variable was falls (coded as yes=1 or no=0). Baseline characteristics and cognitive variables that differed between groups at p<0.15 were included as independent variables in the model and included age, marital status, gender, body mass index, and education.

Data was analyzed using SPSS 24.0 (IBM Corp., Armonk, NY, USA) and a significance level was set at p<0.05.

### Results

#### Characteristics of participants

Overall, 3413 individuals met inclusion criteria and comprised the study population. The mean age was 76.14 years (SD=7.56; range=65-109), 57.3% were married, and 58.6% were female.

Within the sample, 34.10 % (N=1164) reported falling and were assigned to the Falls group. An average of 3.21 (SD=5.09) falls were reported of which 28.8% were injurious falls. Significant differences existed between groups across multiple demographic variables including age, gender, marital status, and education. Groups did not differ in their BMI or physical activity levels. Falls group participants had lower overall strength (grip strength 25.53 kg/m² vs 28.98 kg/m²), slower gait speed (0.73 m/s vs 0.77 m/s), and more impaired balance (tandem stance time: 28.25s vs 32.47s) as compared to those in the No Falls group.

Cognitive performance differed between groups. More data was analyzed using SPSS 24.0 (IBM Corp., Armonk, NY, USA) and a significance level was set at p<0.05.
impaired recall was found in the Falls group in both IWR (4.82 words; SD=1.78; p<0.05) and DWR (3.75 words; SD=2.02; p<0.05) as compared to the No Falls group (IWR=5.08, SD=1.71; DWR=4.01, SD=2.06). Falls group members were, on average, less oriented to week, month, day, and year (mean: 3.62, SD=0.75; p<0.05) as compared to the No Falls group (mean: 3.71, SD=0.65; p<0.05). Numeracy was more impaired in the Falls group with the SST score of 2.93 (SD=1.97) versus 3.09 (SD=1.96) in the No Falls group, but the difference did not reach statistical significance (p=0.05). Groups were not significantly different in their semantic verbal fluency in the Falls group (14.96 animals named, SD=6.42, p>0.05) versus the No Falls group (14.99, SD=6.49).

Full demographic, mobility and cognitive data can be found in Table 1.

### Predictors of falls

Associations between cognition and falls from logistic regression analyses of the whole sample revealed that immediate recall was associated with falls (OR=1.09, 95% CI=1.01-1.17, p=0.026) after adjusting for age, gender, marital status, education, and body mass index. The final logistic regression model was significant with immediate recall as a predictor of falls (Nagelkerke R²=0.037, χ²=35.14, p<0.05) with correctly classifying 65.9% of cases (Table 2). None of the other cognitive predictor variables were significantly associated with falls after controlling for covariates.

### Discussion

This study describes differences in physical and cognitive function based on falls history in a national sample of older adults with CVD. Of all the cognitive processes examined, immediate recall was the only significant predictor of falls indicating that older adults with CVD with impaired immediate recall are at an increased likelihood for falls. Explicitly, as immediate recall declines, the risk of falls increases by 9% in older adults with CVD regardless of age, gender, marital status, education, and body mass index. Evidence suggests that the decline in cognitive function with aging does not affect all memory functions equally⁴⁹. Specifically, deficits in episodic recall or immediate memory tasks are typically noted in older adults⁵⁰. This may explain why immediate recall stood out as the only predictor of falls in this sample of older adults. This study adds to the body of literature by describing the specific cognitive processes which contribute to falls in those with CVD. Although a more comprehensive assessment of cognitive function is warranted, the simple cognitive screening measures used in this study have exposed the predictive ability of cognitive function, specifically immediate recall, on falls in older adults with CVD. Results of this study direct clinicians and researchers to consider these relationships when managing falls risk in older adults with CVD.

In the sample, those who reported falling were older, had more impaired balance, slower gait speed, and decreased overall general body strength than those without a falls history. Differences in these characteristics between fallers and non-fallers may be considered typical as they have been reported to contribute to falls in older adults²¹. When comparing immediate recall performance in the Falls group versus what has been previously reported in a national sample of older adults, IWR in CVD fallers was more impaired (4.82 versus 5.1 words recalled) indicating that this cognitive construct may be more impaired in CVD fallers²⁶. Additionally, other areas of cognitive function (delayed recall, orientation, and numeracy) were more impaired in CVD fallers. Collectively, these data suggest that the profile of a faller with CVD may be comprised of more than just impaired physical function, and that consideration should be given to the potential underlying cognitive dysfunction that may contribute to falls.

The sample in this study reported more falls (34.10%) than what was previously reported in older adults with CVD²,³¹. In the Cardiovascular Health study, 13.2% of older adults with CVD related risk factors reported falling²¹. Another large epidemiological study similar to the HRS reported a 19.2% falls incidence in CVD with an increased risk with advanced age and a greater degree of CVD comorbidity². A strong link has been established between comorbidities and falls in the elderly in previous literature due to direct effects of individual conditions such as depression, visual field defects³²-³⁴, orthostatic hypotension³⁵, cerebral hypoperfusion³⁶, arrhythmias³⁷, low bone density³⁸, muscle weakness, gait deficit³⁸, peripheral neuropathy³⁹ and postural imbalance. Subsequently, the risk of falls is compounded as the number of comorbidities increase⁴⁰. In order to describe the cognitive function of the sample without the potential confounding of CVD associated diagnoses on cognition and falls, this study did not include...
older adults with comorbidities including a history of depression, diabetes, or stroke. These diagnoses may have been present in other studies which reported falls in CVD and therefore the fall rates in this study reflect those of older adults with CVD who do not have those additional diagnoses. Lastly, the sample included adults whose ages ranged from 65-109 and despite controlling for the effect of age on falls in regression modeling, a review of falls rates by age range was not performed. It is possible that falls incidence would be different when age groupings are considered, and therefore more study is necessary.

Impaired immediate recall has previously been identified as a significant predictor of falls in community dwelling and in hospitalized older adults, but not specifically in older adults with CVD. Results of this study are consistent with previous findings indicating the odds of falling increases when immediate recall is impaired, however the odds ratio in this study exceeded those previously reported. Anstey and colleagues found that falls increased by 5% when immediate recall was impaired in community dwelling older adults, however, when they adjusted their regression model for CVD and lifestyle factors, immediate recall was no longer a significant predictor of falls. Whereas in this study, the odds ratio for falling increased by 9% when immediate recall was impaired.

Orientation has been identified as the cognitive area most often screened within a falls risk assessment. Although orientation was significantly different in fallers, it was not a significant predictor of falls. Conversely, the cognitive domain of executive function which is considered a key contributor to falls and of which is suggested to be included within a falls risk assessment was not significantly different between groups. The nature of performing a large epidemiological survey, like HRS, might not be conducive to having surveyors perform complex cognitive assessments which require advanced training and education during data collection. Therefore, it may be possible that the cognitive measures used were not robust enough to detect differences in cognitive processes reported to influence falls and further study should be completed.

Strengths of the study include the use of a large national sample of older adults with CVD and the use of cognitive and physical mobility screening measures which can be replicated in clinical settings. However, limitations exist. First, CVD data was gathered by HRS surveyors through a ‘yes’/’no’ response by the respondent or a proxy and verification of medical history was not performed. Group assignment was completed by falls history recall over a period of two years and falls may have been missed or not reported. Although falls risk might differ by CVD diagnosis, secondary analysis revealed that the majority of the sample (88%) had underlying hypertension and that the relationship with falls was irrespective of the presence of advanced cardiac disease. Future studies comparing the relationship of falls with individuals having hypertension alone, and those with hypertension along with added cardiac comorbidities would be valuable. Other factors contributing to falls such as postural hypotension were unable to be incorporated into analyses due to the nature of the data, and warrants further research. Lastly, as this was a cross-sectional study, causality between cognitive performance and falls in CVD cannot be established.

Data from this study underlies the importance for using a structured cognitive assessment as a part of a falls risk assessment in older adults with CVD. As CVD pathology and disease treatment are likely to contribute to the presence of impaired cognition and/or mobility, cognitive function should be screened within a falls risk assessment with specific screening of immediate recall especially in those with a history of falling.

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