Research Report

Increased Risk of Falling in Older Community-Dwelling Women With Mild Cognitive Impairment

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Background. Falls are a major health care problem for older people and are associated with cognitive dysfunction. Mild cognitive impairment (MCI) is an increasingly recognized clinical problem. No study has comprehensively compared people with and without MCI for fall risk factors in both the physiological and cognitive domains.

Objective. The purpose of this cross-sectional study was to comprehensively compare fall risk factors in community-dwelling older women with and without MCI.

Design. A cross-sectional design was used in the study.

Methods. Community-dwelling women (N=158) with Folstein Mini Mental State Examination scores of ≥24 participated in the study. The Montreal Cognitive Assessment (MoCA) was used to categorize participants as either having or not having MCI. Each participant's fall risk profile was assessed with the Physiological Profile Assessment (PPA). Three central executive functions were assessed: (1) set shifting was assessed with the Trail Making Test (part B), (2) updating (ie, working memory) was assessed with the Verbal Digits Backward Test, and (3) response inhibition was assessed with the Stroop Colour-Word Test.

Results. Both the composite PPA score and its subcomponent, postural sway performance, were significantly different between the 2 groups; participants with MCI had higher composite PPA scores and greater postural sway compared with participants without MCI. Participants with MCI performed significantly worse on all 3 central executive function tests compared with participants without MCI.

Limitations. A screening tool was used to categorize participants as having MCI, and fall risk factors were compared rather than the actual incidence of falls.

Conclusions. Fall risk screening may be prudent in older adults with MCI.

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[Liu-Ambrose TY, Ashe MC, Graf P, et al. Increased risk of falling in older community-dwelling women with mild cognitive impairment. *Phys Ther*. 2008;88:1482–1491.]

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Falls are a major health care problem for older people, and about 30% of community-dwellers over the age of 65 years experience one or more falls every year.[1] Older women have a higher incidence of falls compared with older men.[1] The proportion of women who fall increases from about 30% in those aged 65 to 69 years to greater than 50% in those over the age of 85 years. The proportion of men who fall increases from 13% in those aged 65 to 69 years to approximately 30% in those aged 80 years and older.[1]

Falls are not random events[2] and occur, at least in part, due to physiological impairments, such as impaired balance, muscular weakness, and slowed reaction time.[3] Falls also are associated with cognitive dysfunction.[4] Approximately 60% of older people with cognitive impairment fall annually; this incidence is approximately twice that of older people without cognitive impairment.[4,5] Tinetti and coworkers[4] reported that compared with older adults without cognitive impairment, the odds of falling are 5 times greater in older adults with cognitive impairment; this compared with an odds ratio of 3.8 and 1.9 for disability in the lower extremities and impaired balance and gait, respectively. Thus, the older "faller" with cognitive impairment is at increased risk for major injury such as fracture and head trauma.[5]

Although there has been dedicated research on falls in older adults with dementia (eg, Alzheimer disease [AD]),[6,7] very little research has focused on people with mild cognitive impairment (MCI). Consequently, the incidence of falls in this population and key factors for fall risk remain poorly defined. Mild cognitive impairment is distinct from dementia and is conceptually defined as a clinical entity characterized by cognitive decline that is greater than that expected for an individual's age and education level but that does not notably interfere with activities of daily living (ADLs).[8,9] Longitudinal studies have shown that older people with MCI develop AD at a rate of 10% to 30% annually,[10,11] whereas elderly people without MCI develop dementia at a rate of 1% to 2% annually.[10] Mild cognitive impairment also is more prevalent than dementia.[12] According to the 1994 Canadian Study of Health and Aging, 8% of Canadians aged 65 years or older had dementia, whereas 16.8% had MCI.[13]

Older adults with MCI have impaired balance and gait[14,15] as well as impaired executive functions[16,*]; each of these impairments is associated with falls.[17] Thus, fall risk screening and prevention may be a key component in the medical management of older adults with MCI. However, no single study to date has comprehensively compared older adults without MCI with older adults with MCI for well-recognized factors for fall risk. Specifically, no previous studies have compared physiological fall risk between these 2 populations using a valid and reliable measure, such as the Physiological Profile Assessment (PPA),[18] which is a validated tool for quantifying physiological fall risk based on a combination of physiological measures: (1) postural sway, (2) hand reaction time, (3) knee extension strength (force-generating capacity), (4) proprioception, and (5) edge contrast sensitivity. The PPA is different from clinical measures of balance and gait, as it first quantifies performance within the specific physiological domains relevant to fall risk and then computes a composite fall risk score (ie, a standardized score). A marked deficit in any 1 of the 5 physiological domains may increase the risk for falls (ie, higher composite fall risk score). However, a combination of mild or moderate impairments in each of 5 physiological domains also may increase the risk for falling. The composite fall risk score has a 75% predictive accuracy for falls in older people.[19]

No previous studies have compared cognitive performance of key executive functions that are associated with fall risk between older adults without MCI and those with MCI. Previous work has identified impaired set shifting, updating (ie, working memory), and response inhibition to be associated with increased fall risk.[17,20–22] Therefore, the purpose of this cross-sectional study was to comprehensively compare both physiological and cognitive factors for fall risk in older women with and without MCI.

Method

Participants

The sample for this cross-sectional analysis consisted of 158 women who consented to be participants in a 1-year randomized controlled trial of exercise. Women were recruited for the study if they: (1) were aged 65 to 75 years; (2) were living independently in their own home; (3) had a score of ≥24 on the Folstein Mini-Mental State Examination (MMSE)[23]; and (4) had visual acuity of at least 20/40, with or without corrective lenses. Women were excluded if they: (1) had a diagnosed neurodegenerative disease (eg, AD) or stroke; (2) were taking psychotropic drugs; (3) did not speak and understand English; (4) had moderate to significant impairment with ADLs, as determined by interview; (5) had taken cholinesterase inhibitors within the last 12 months; (6) had taken antidepressants within the

* Executive functions are higher-order cognitive processes that control, integrate, organize, and maintain other cognitive abilities. The cognitive processes are essential to the ability to carry out health-promoting behaviors, such as medication management, dietary and lifestyle changes, self-monitoring of responses, and follow-up with health care professionals.

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last 6 months; or (7) had received estrogen replacement therapy within the last 12 months.

Participants were recruited through newspaper advertisements and articles, television features, flyers posted at local community centers, and advertisements through the Physiotherapy Association of British Columbia (Figure). All interested individuals were initially screened by telephone, and 41 individuals were excluded. Those who were eligible based on the telephone screening were invited to attend an information session. Two hundred eighteen individuals attended an information session; 7 individuals were excluded during these sessions. One hundred sixty women consented and attended the baseline assessment. During the baseline assessment, 1 person was excluded by the study physician due to a possible neurological condition, and 1 person decided to withdraw due to anxiety associated with the standard neuropsychological tests. Thus, 158 women completed the baseline assessment. The study was approved by the relevant hospital and university ethics boards, and all participants provided written informed consent.

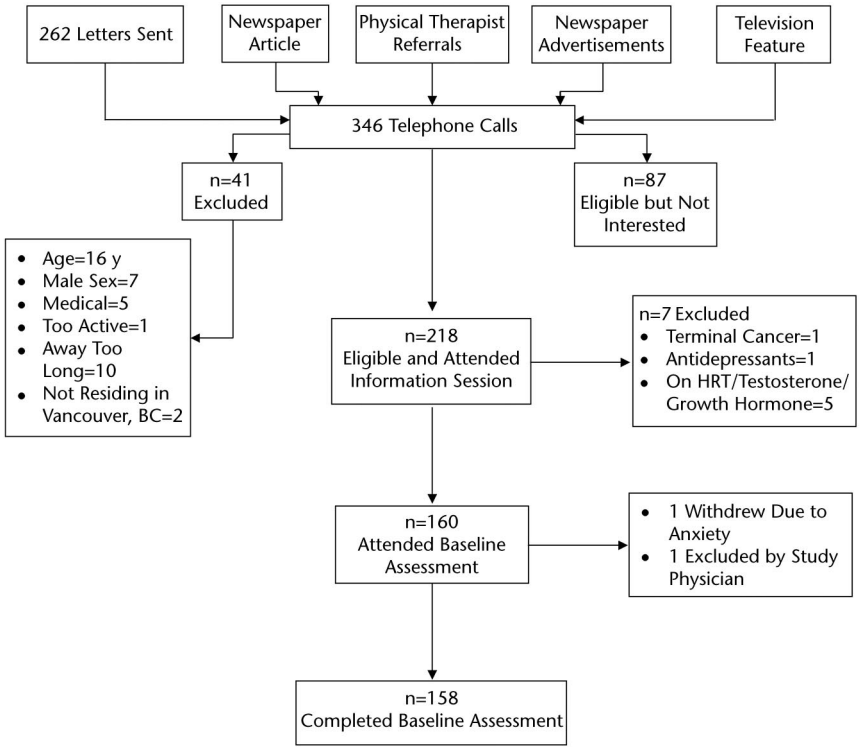

Figure.
Flow chart of participants. HRT=hormone replacement therapy.

Descriptive Variables

Global cognitive state was assessed using the MMSE.[23] General health and socioeconomic status were ascertained by a questionnaire. Participants underwent a 15-minute physician assessment to confirm current health status and eligibility for the study. The occurrence of falls in the last 12 months was ascertained by means of an interview with the study physician.

Because depression may influence performance on neuropsychological tests and has been identified in the prodromal stage as a risk factor for developing AD,[24] the 15-item Geriatric Depression Scale[25] was used to screen for depression. A score of 11 or higher indicates severe depression.[25] The Functional Comorbidity Index was calculated to estimate the degree of comorbidity associated with physical functioning.[26] The Functional Comorbidity Index explains more variance in physical function scores compared with indexes designed to predict mortality.[26] This scale's score is the total number of comorbidities.

Results from large prospective cohort studies indicate that regular participation in low-intensity physical activity is associated with a reduced risk for dementia[27] and with better cognitive performance among older adults.[28] Thus, current level of physical activity (ie, over the previous 7-day period) was determined with the Physical Activities Scale for the Elderly (PASE) self-report questionnaire.[29,30] This 10-item scale, designed for people aged 65 years or older, measures the average number of hours per day spent participating in leisure, household, and occupational physical activities over the previous 7-day period. The time spent in each activity is multiplied by a weighted value that reflects the amount of energy expended by the respondent. These weighted values then are summed to give a composite PASE score. Higher scores indicate higher levels of physical activity. Washburn et al[31] reported that scores may range from 0 to 400 or higher. The PASE questionnaire is valid and reliable for older adults with no serious physical limitations.[29,30] In a sample of 222 individuals, PASE scores were significantly correlated with postural balance, grip strength, leg strength, self-assessed health status, and Sickness Impact Profile scores.[29] Test-retest reliability coefficients (Pearson *r*) for

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Table 1.
Physiological Profile Assessment (PPA)–Short Form

PPA Task	Description	Measure
Postural sway	Participants stood as still as possible for 30 s on a 15-cm-thick, medium-density foam rubber mat with their eyes open, wearing the Lord swaymeter. Sway was recorded on a sheet of millimeter graph paper fastened to the top of an adjustable-height table.	Total sway path (in millimeters) was determined from the path traced.
Quadriceps femoris muscle strength	A simple strain gauge assessed dominant quadriceps femoris muscle (isometric) strength to the nearest 0.5 kg. Participants were seated with the hip and the knee joint at 90° of flexion.	Best of 3 trials (in kilograms)
Hand reaction time	A light was used as the stimulus, and depression of a switch by the finger was used as the response.	Average of 10 trials (in milliseconds)
Proprioception	Seated participants, with eyes closed, were asked to align their lower limbs on either side of a 60- × 60-cm, 1-cm-thick clear acrylic sheet standing on edge and inscribed with a protractor.	Difference (in degrees) in matching the great toes
Edge contrast sensitivity	The Melbourne Edge Test was used. This test presents 20 circular patterns containing edges with reducing contrast. Correct identification of the orientation of the edge on the patches provides a measure of contrast sensitivity in decibel units (dB), where $dB = -10\log_{10}$ contrast.	Number of last correctly identified circle (in decibel units)

the PASE were .75 for self-administration and .68 when administered during a telephone interview.[29]

General mobility was assessed with the Timed "Up & Go" Test (TUG).[32] Participants were instructed to rise from a standard chair with arms, walk a distance of 3 m, turn, walk back to the chair, and sit down again. The mean of 2 trials was calculated and used for statistical analysis. A TUG cutoff of at least 13.5 seconds correctly classified participants as fallers in 90% of cases.[33]

Classification of Possible Mild Cognitive Impairment

There are no consensus criteria for the clinical classification of MCI.[34] The Montreal Cognitive Assessment (MoCA), a brief screening tool for MCI[35] with high sensitivity and specificity, was used to categorize participants as with, or without, possible MCI. It is a 30-point test covering 8 cognitive domains: (1) attention and concentration, (2) executive functions, (3) memory, (4) language, (5) visuo-constructional skills, (6) conceptual thinking, (7) calculations, and (8) orientation. Scores below 26 are considered to be indicative of possible MCI. A bonus point is given to individuals with less than 12 years of education.

Physiological Fall Risk Profile

The Physiological Profile Assessment (PPA) has 2 versions: a comprehensive (or long) version and a screening (or short) version.[18] Although the comprehensive version provides information on a broader array of physiological functions than the short form, the 2 versions provide the same composite fall risk score. Each participant's physiological fall risk profile was assessed in this study with the short form of the PPA. The short form takes 15 minutes to administer and includes: (1) postural sway, (2) hand reaction time, (3) knee extension strength, (4) proprioception, and (5) edge contrast sensitivity. These 5 physiological functions were identified from discriminant function analyses as being the most important for discriminating between fallers and nonfallers in both institutional and community settings.[36–38]

The PPA is a valid and reliable measure of fall risk in older people.[18] Based on a participant's performance, the PPA computes a composite fall risk score (standardized score) that has a 75% predictive accuracy for falls in older people. The composite PPA score is derived from discriminant function analysis using data from large-scale studies.[36–38] The discriminant function is made up of weighted scores of the 5 key components. These weightings (ie, canonical correlation coefficients) are −.33 for edge contrast sensitivity, .20 for joint position sense, −.16 for isometric quadriceps femoris muscle strength, .47 for hand reaction time, and .51 for postural sway on a foam-rubber mat with eyes open. Composite PPA scores below 0 indicate a low risk for falling, scores between 0 and 1 indicate a mild risk for falling, scores between 1 and 2 indicate a moderate risk for falling, and scores above 2 indicate a high risk for falling. Table 1 describes the tasks and measures of the short form of the PPA. The test-retest reliability (ie, intraclass correlation coefficient) for the 5 key PPA components is .57 for postural sway, .69

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for hand reaction time, .97 for knee extension strength, .50 for proprioception, and .81 for edge contrast sensitivity.[18]

Cognitive Performance of Executive Functions

This study focused on 3 central executive functions: (1) set shifting, (2) updating (ie, working memory), and (3) response inhibition.[39] Although these 3 executive functions are moderately correlated with one another, they are clearly separable.[39] These functions often are hypothesized to contribute to performance of complex "frontal" tasks. They also are highly specific and can be defined in a fairly precise manner.[39] Set shifting requires a person to go back and forth between multiple tasks or mental sets.[39] Updating involves monitoring incoming information for relevance to the task at hand and then appropriately updating the informational content by replacing old information that is no longer relevant with new incoming information. Response inhibition involves deliberately inhibiting dominant, automatic, or prepotent responses. Previous studies[17,20] have demonstrated that poor set shifting and response inhibition are predictive of falls.

Set shifting. The Trail Making Test (part B) was used to assess set shifting.[40] This standardized test of set shifting consists of a page with encircled numbers and letters (the numbers extend from 1 to 13 and the letters from A to L). Participants were instructed to draw a line as quickly and as accurately as possible from 1 to A, A to 2, 2 to B, B to 3, and so on until they completed the task. The amount of time (in seconds) it took to complete the task was recorded. Faster Trail Making Test (part B) times are indicative of better set shifting.

Updating. The Verbal Digits Backward Test was used to assess updating.[41] This test consists of 7 pairs of random number sequences that the assessor reads aloud at the rate of one per second, and the participant's task is to repeat each sequence in an exactly reversed order. The sequence begins with 3 digits and increases by one at a time up to a length of 9 digits. The test includes 2 sequences of each length, and testing ceases when the participant fails to recollect any 2 sequences with the same length. The score recorded, ranging from 0 to14, is the number of successful sequences. Higher scores indicate better updating.

Response inhibition. The Stroop Colour-Word Test[42] was used to assess response inhibition. Lezak[43] found that people who do poorly on this test have difficulty concentrating and warding off distractions. For the Stroop Colour-Word Test, participants were shown a page with names of colors printed in incongruent colored inks (eg, the word "blue" printed in red ink). Participants were asked to name the ink color in which the words were printed (while ignoring the word itself). The time (in seconds) participants took to read 112 words was recorded, and this measurement was used for statistical analysis. Faster times indicate better response inhibition.

Data Analysis

Data were analyzed using SPSS Windows version 15.0.[†] Descriptive data are reported for variables of interest. Comparisons of group characteristics were undertaken using a chi-square test for differences in proportions and Student *t* tests for differences in means. The level of association among the 3 executive functions, the composite PPA score, and the 5 PPA components was determined using the Pearson product moment correlation coefficient. The alpha level was set at $P \leq .05$.

To minimize the overall probability of making a type I error, between-group differences in physiological fall risk profile and cognitive performance of executive functions were established using 2 separate multivariate analyses of variance (MANOVAs). For the physiological fall risk profile MANOVA, the composite PPA score and the 5 key PPA components were entered as the dependent variables and age was entered as a covariate. For the cognitive performance of executive functions MANOVA, the Trail Making Test (part B) completion time, the Verbal Digits Backward Test score, and the Stroop Colour-Word Test completion time were entered as the dependent variables and age and education were entered as covariates. If the MANOVA demonstrated a significant group effect, between-group differences on individual outcomes measures were determined by analysis of variance. The overall alpha level was set at $P \leq .05$.

Results

The mean age of the entire cohort was 69.6 years (SD=3.0) (Tab. 2). The participants had a mean number of 2 self-reported chronic conditions; arthritis and low bone mass were the 2 most common chronic conditions. Fifty-two participants (32.9%) reported one or more falls in the last 12 months.

The mean MoCA score for the entire cohort was 25.2 (SD=3), just below the recommended cutoff score of 26 for MCI.[35] Seventy-two women scored below 26 on the MoCA. Table 2 reports descriptor variables for the 2 groups of women. Older women with MCI had significantly lower body mass than older women without MCI ($P=.02$); they also had a lower body mass index ($P=.05$). Although there was no significant

[†] SPSS Inc, 233 S Wacker Dr, Chicago, IL 60606.

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between-group difference for history of falls (P=.40), a greater proportion of older women without MCI had a history of falling compared with older women with MCI (ie, 36% versus 29%). However, the accuracy of recalling falls is limited.[44] It also is possible that older women with MoCA scores of ≥26 can recall their falls better compared with older women with MoCA scores below 26.

Correlation Coefficients

The composite PPA score was significantly associated with all 3 executive functions (P≤.05). The correlation coefficients among variables of interest are reported in Table 3.

Physiological Fall Risk Profile

The data from the PPA are summarized in Table 4. Both groups had a mean composite PPA score between 0 and 1.0, indicating a mild risk for falling. There was an overall significant difference between the 2 groups on physiological fall risk profile (MANOVA, Hotelling Trace=.09, P=.04). Both the composite PPA score and postural sway performance (P≤.03) were significantly different between the 2 groups. Participants with MCI had significantly higher composite PPA scores (ie, higher physiological risk of falling) and increased postural sway compared with participants without MCI. Specifically, there was an 88% and a 21% difference, respectively, in composite PPA score and postural sway performance between the 2 groups. There were no significant differences between the 2 groups in any of the other 4 key PPA components (P≥.10).

Cognitive Performance of Executive Functions

The data from the 3 central executive functions tests are summarized in Table 5. There was an overall significant difference between the 2 groups on these tests (MANOVA, Hotelling Trace=0.17, P=.001). Participants with MCI performed significantly worse on all 3 central executive functions tests (P≤.04) compared with participants without MCI.

Table 2.
Descriptive Statistics for Key Descriptors (N=158)[a]

Variable	MoCA Score ≥26 (n=86)	MoCA Score <26 (n=72)
Age (y)	69.7 (2.8)	69.5 (3.2)
Height (cm)	161.8 (6.8)	160.8 (9.1)
Mass (kg)	72.0 (14.5)	66.4 (5.4)[c]
Body mass index (m/kg^2)	27.4 (4.9)	25.8 (5.4)[c]
MMSE score (maximum: 30 points)	28.9 (1.2)	28.3 (1.4)[d]
MoCA score (maximum: 30 points)	27.4 (1.5)	22.6 (2.0)[e]
Geriatric Depression Scale score (maximum: 15 points)	0.43 (1.4)	0.72 (2.1)
Education, count (%)[b]		
Less than grade 9	1 (1.2)	3 (4.2)
Grades 9–12 without certificate or diploma	4 (4.6)	4 (5.6)
High school certificate or diploma	9 (10.5)	16 (22.2)
Trades or professional certificate or diploma	15 (17.4)	14 (19.4)
University certificate or diploma	17 (19.8)	11 (15.3)
University degree	40 (46.5)	24 (33.3)
Falls in the last 12 mo, count (%)	31 (36)	21 (29)
Functional Comorbidity Index (maximum: 18 points)	2.3 (1.9)	2.0 (1.4)
Physical Activity Scale for the Elderly	122.8 (63.4)	115.5 (52.3)
Timed "Up & Go" Test (s)	6.7 (1.4)	6.7 (1.4)

[a] Values are mean (SD) unless otherwise specified. MMSE=Mini-Mental State Examination, MoCA=Montreal Cognitive Assessment.
[b] Count=number of "yes" cases within each group.
[c] Significantly different from MoCA ≥26 at P≤.05.
[d] Significantly different from MoCA ≥26 at P<.01.
[e] Significantly different from MoCA ≥26 at P<.001.

Discussion

Mild cognitive impairment is increasingly recognized as a clinical problem,[9] and the current study showed that older women with MCI demonstrated a greater number of fall risk factors than older women without MCI. Specifically, older women with MCI had significantly higher composite PPA scores, which was due, in part, to significantly increased postural sway. Impaired executive functions are associated with falls,[17,20,45,46] and our participants with MCI also performed significantly lower on tests of 3 central executive functions. To our knowledge, this is the first study that has comprehensively compared well-recognized fall risk factors—in both the physiological and cognitive domains—between older women with MCI and older women without MCI.

The observation of increased postural sway in older women with MCI concurs with the observations of Franssen and coworkers,[14] who found that, after adjusting for age, individuals with MCI or mild AD had significantly reduced balance and limb coordination compared with individuals without cognitive impairment. The present study extends these previous findings by demonstrating that older women with MCI have a significantly worse *global* physiological fall risk profile, as dem-

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Table 3.
Pearson Product Moment Correlation Coefficient Matrix Between Composite Physiological Profile Assessment (PPA) Score, PPA Key Components, Trail Making Test (Part B), Verbal Digit Span Backward Test, and Stroop Colour-Word Test (N=158)

Variable	Trail Making Test (Part B) (s)	Verbal Digit Span Backward Test (Maximum: 14 Points)	Stroop Colour-Word Test (s)
Composite PPA score	.37[a]	−.36[a]	.23[a]
Postural sway (mm)	.15	−.13	.11
Quadriceps femoris muscle strength (kg)	−.14	.08	−.08
Hand reaction time (s)	.19[b]	−.12	.28[a]
Proprioception (°)	.08	.13	−.003
Edge contrast sensitivity (dB)	−.08	.06	.04

[a] $P<.01$.
[b] $P<.05$.

Table 4.
Descriptive Statistics and Analysis of Variance Results Related to the Composite Physiological Profile Assessment (PPA) Score and the 5 Key PPA Components: Mean Values Adjusted for Age ± Standard Error (SE) and 95% Confidence Interval (CI)[a]

Variable	MoCA Score ≥26 (n=86)	MoCA Score <26 (n=72)	
	Mean (SE), 95% CI	Mean (SE), 95% CI	*P*
Composite PPA score	0.06 (0.10), −0.14 to 0.26	0.51 (0.11), 0.29 to 0.72	<.01
Postural sway (mm)	114.0 (9.1), 96.0 to 132.1	144.2 (9.9), 124.7 to 163.7	.03
Quadriceps femoris muscle strength (kg)	30.3 (0.8), 28.7 to 32.0	28.4 (0.9), 26.6 to 30.2	.11
Hand reaction time (ms)	264.8 (5.9), 253.1 to 276.5	273.4 (6.4), 260.8 to 286.1	.32
Proprioception (°)	1.0 (1.0), 0.82 to 1.2	1.3 (1.1), 1.1 to 1.5	.10
Edge contrast sensitivity (dB)	22.9 (0.5), 22.0 to 23.8	21.9 (0.5), 20.9 to 22.8	.13

[a] MoCA=Montreal Cognitive Assessment.

onstrated by a valid and reliable tool,[19] than those without MCI. It should be highlighted that impaired physiological function, such as impaired balance, for people with MCI has clinical significance beyond fall risk. For example, for people with MCI, current evidence suggests that impaired physiological function also is related to increased risk of AD.[15]

It is possible that people with MCI have a greater impairment of physiological function than those without MCI because of frank structural and functional brain abnormalities. Imaging studies have demonstrated that white matter lesions, global brain atrophy, frontal lobe atrophy, and reduced cerebro-arterial blood flow are associated with both impaired mobility and impaired balance.[47–50] Rosano and coworkers[51] recently demonstrated that reduced gray matter volumes in regions crucial for motor control are associated with slower gait and poorer balance, and the association appears to be independent of other diffuse brain abnormalities such as white matter lesions. Although the current study was not designed to explain why people with MCI may have increased sway, there is evidence that indexes of general physiological integrity, such as the ability to balance, are "biomarkers" of brain structure and function.[48]

In addition to their association with impaired physiological function, structural and functional brain abnormalities also are associated with impaired cognition, including executive functions.[52] For example, both lower prefrontal gray matter volume and greater levels of white matter lesions are related to impaired set shifting.[53] Functional changes, such as changes in activation, oxygen utilization, and glucose metabolism that disrupt the frontal-subcortical neuronal systems, also compromise executive functions.[54]

Impaired executive functions are associated with falls[17,20,45,46] and injurious falls.[20] It is tempting to speculate that structural and functional brain abnormalities may underlie at least part of the association between impaired executive functions and falls. Future brain imaging studies in older adults with MCI would help test the mechanism of this association.

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Table 5.
Descriptive Statistics and Analysis of Variance Results Related to the Executive Function Tests: Mean Values Adjusted for Age ± Standard Error (SE) and 95% Confidence Interval (CI)[a]

Variable	MoCA Score ≥26 (n=86)	MoCA Score <26 (n=72)	
	Mean (SE), 95% CI	Mean (SE), 95% CI	*P*
Trail Making Test (part B) (s)	88.2 (3.9), 80.5 to 95.9	115.5 (4.3), 107.1 to 124.0	<.001
Verbal Digits Backward Test (maximum: 14 points)	5.1 (0.2), 4.6 to 5.6	3.8 (0.3), 3.3 to 4.4	.001
Stroop Colour-Word Test (s)	91.5 (2.7), 86.2 to 96.9	101.8 (3.0), 95.9 to 107.6	.01

[a] High Trail Making Test (part B) time values, low Verbal Digits Backward Test scores, and high Stroop Colour-Word Test time values indicate impaired performances. MoCA=Montreal Cognitive Assessment.

This study also demonstrated a significant difference in body mass—participants with MCI had a significantly lower body mass compared with those without MCI. This finding concurs with recent evidence demonstrating that weight loss precedes the diagnosis of dementia in women by several years.[55] Executive functions are essential to the older person's ability to uptake and carry out health-promoting behaviors[54] such as medication management, dietary and lifestyle changes, self-monitoring of responses, and follow-up with health care professionals. Thus, older adults with MCI may have lower body mass, at least in part, due to their decreased ability to initiate and sustain health-promoting behaviors. Other reasons include predementia apathy, loss of initiative, and reduced olfactory function.[55] It should be highlighted that low body mass is a significant risk factor for injurious falls.[56] Thus, older women with MCI may be at risk for injurious falls due to both impaired executive functioning and low body mass.

A clinical implication of our results is that fall risk screening and prevention should be a key component in the clinical management of older adults with MCI. Specifically, fall risk screening in this population should include standard neuropsychological tests of executive functioning and measures of postural sway. Furthermore, effective fall prevention strategies for people with MCI should not target not only physiological function but also executive functions. Current evidence suggests that cardiovascular training benefits executive functions in adults aged 55 years and older.[57]

A limitation of our study is that our participants were categorized as with, or without, MCI based on the MoCA, a screening tool for MCI, rather than on the results of comprehensive neuropsychological testing accompanied by a clinical assessment. Currently, however, neuropsychological aspects of the classification of MCI are poorly defined.[34] It should be highlighted that a MoCA score of 26 has a sensitivity of 90% for detecting MCI.[35] Another limitation is that we compared key fall risk factors between older women with MCI and those without MCI rather than the actual incidence of falls. Thus, future prospective studies using falls as the primary outcome measure are needed to confirm that older adults with MCI are indeed at greater risk for falls than those without MCI.

Conclusion

The results of this study indicate that older women with MCI—but not dementia—have greater risk for falls than those without MCI. Our results suggest fall risk screening may be prudent in people with MCI. If fall prevention strategies[58,59] prove effective among people with MCI, it would have enormous clinical importance. At present, falls cannot be prevented among people with dementia.[60] Identifying people who are at risk earlier in the process may be a valuable window of opportunity for intervention.

All authors provided study concept and design, acquisition of data, analysis and interpretation of data, preparation of manuscript, and critical review of manuscript. Dr Liu-Ambrose, Dr Graf, and Dr Beattie provided acquisition of data and research funds.

The Vancouver Foundation (British Columbia Medical Services Foundation grant BCM06-0035) and the Michael Smith Foundation for Health Research (Establishment Grant) supported this study.

A poster presentation of this research was given at the Second International Congress on Gait and Mental Function; February 1–3, 2008; Amsterdam, the Netherlands.

This article was received April 17, 2008, and was accepted July 30, 2008.

DOI: 10.2522/ptj.20080117

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