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Effect of Pain and Mild Cognitive Impairment on Mobility

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Abstract

Background/Objectives—Pain, mild cognitive impairment (MCI), and mobility limitations are common among older adults. The separate and combined effect of pain and MCI on mobility has not yet been elucidated. This study examines the associations of pain and MCI on performance-based and patient-reported mobility outcomes among older primary care patients with mild-to-moderate self-reported mobility limitations.

Design—Cross-sectional analysis.

Setting—Academic community outpatient clinic.

Participants—430 primary care patients aged ≥ 65 years at risk for mobility decline enrolled in the Boston Rehabilitative Impairment Study in the Elderly.

Measurements—The Brief Pain Inventory (BPI) identified participants with an average score of >3 with pain. MCI was defined using age-adjusted scores on a neuropsychological battery. Multivariable linear regression models assessed associations between Pain/MCI status and mobility performance (habitual gait speed, the Short Physical Performance Battery), and patient reports (Late Life Function and Disability Instrument [LLFDI]).

Results—The prevalence of pain and MCI were 34% and 42%, respectively. Pain only and MCI only were present among 17% and 25%, respectively. Both pain and MCI was present in 17%; 41% had neither condition. Participants with both pain and MCI performed significantly worse than all others on all mobility outcomes ($p<0.001$). Participants with MCI only or pain only also performed significantly worse in all mobility outcomes as compared to participants with neither condition ($p<0.001$).

Conclusion—The presence of mild-to-moderate pain or MCI was independently associated with poor mobility status, and the presence of both comorbidities was associated with the poorest status. Primary care practitioners who encounter older patients in need of mobility rehabilitation should consider both pain and MCI within their screening tools and paradigms of care.

INTRODUCTION

Pain represents a clinical entity frequently encountered in geriatric and rehabilitative care. One-third of older adults experience pain daily (1). Widespread and chronic pain have been linked to mobility limitation (2-4).

Mild cognitive impairment is associated with mobility problems and difficulty with daily tasks involving physical function (5). Population-based studies report that 1 in 5 older adults manifest symptoms of mild cognitive impairment (MCI) (6). Among a representative cohort of older primary care patients at risk for mobility decline, 42% manifested MCI, and mobility was worse among those with MCI as compared to those without (7).

Few studies have described the overlap between the two conditions among primary care patients. Preliminary evidence suggests that the presence of both pain and MCI may have an even greater impact on physical functioning than either of these conditions separately (8). To our knowledge, only one study examines the co-occurrence of pain and MCI, and it did so with an exclusive focus on low back pain (8). Among older adults, pain most commonly presents in multiple body sites, making these findings difficult to generalize (4).

Studies suggest that older adults living with both pain and MCI likely experience mobility problems requiring rehabilitative care (3,4,5,7,8). Targeted treatment approaches for pain often involve interactive, multi-modal therapies, such as physical and occupational therapy. Cognitive function plays a critical role in a patient's ability to benefit from rehabilitative care as therapies are reliant upon the patient's ability to learn and integrate new information, both within the clinical environment while under supervision, and unsupervised at home.

Two aims were addressed in this study: 1) to characterize the demographics and health status of participants based on pain and MCI status; 2) to evaluate functional limitations based on pain and MCI status; We hypothesized that: 1) participants with both pain and MCI (Pain+/MCI+) will manifest higher comorbidity than individuals with one (Pain+/MCI– or Pain–/MCI+) or neither of these conditions (the reference group, Pain–/MCI–); 2) participants with Pain+/MCI+ will manifest more severe mobility limitations at as compared with individuals with one (Pain+/MCI– or Pain–/MCI+) or neither (Pain–/MCI–) of these conditions.

METHODS

A cross-sectional analysis was conducted using data from the Boston Rehabilitative Impairment Study in the Elderly (Boston RISE). (7). Briefly, Boston RISE is a prospective study of 430 community-dwelling older adults (age ≥ 65 years) residing in the Greater Boston area who are at risk for mobility decline. Recruitment was based upon U.S. Census data 2000, to ensure a sample representative of the ethnic, racial, and gender distribution of older adults residing within a 10-mile radius of our research center. Participants were recruited between December 2009 through January 2012 through primary care clinics at two large academic medical centers in Boston, MA. Eligible participants were identified through a healthcare database and telephone screening interviews, and invited to an initial screening and assessment visit. Potential participants were subsequently invited to undergo supplementary screening tests. Inclusion criteria were the following: community-dwelling older adults (≥ 65 years), ability to understand and communicate in English, and self-reported difficulty with walking half a mile (6 blocks) or climbing one flight of stairs (10 steps). Participants were excluded for: the presence of terminal illness, significant visual impairment, medical problems that would interfere with testing in a safe manner, planned major surgery, and planned move from the area within 2 years, moderate to severe cognitive impairment (Mini Mental State Examination score <18) (9) and severe mobility-related disability (10). Participants gave written informed consent before participation. This study was approved by the Institutional Review Board of Spaulding Rehabilitation Hospital.

Measures

Pain—Pain was measured using the pain severity subscale of the Brief Pain Inventory (BPI) (11,12), a reliable test commonly used in observational and clinical trials (13). BPI addresses four aspects of pain: pain now, pain on average, pain at its least, and pain at its worst in the last week (0-10 numeric rating scale, 10 indicating excruciating pain). We used a cut point of ≥ 3 to indicate the presence of moderate-severe pain, which was characterized as Pain positive (+) (3). Scores < 3 were designated as Pain negative (−).

Mild Cognitive Impairment (MCI)—Participants were classified as having MCI based on performance on three neuropsychological tests: the Trail Making Test (TMT), the Digit Symbol Substitution Test (DSST), and the Hopkins Verbal Learning Test, Revised (HVLT-R). The Trail Making Test (parts A and B) is a reliable and valid diagnostic tool for the assessment of executive function.. (14,15). This score quantifies the time it took for participants to complete each part of the test; shorter completion times indicate better performance. The Digit Symbol Substitution Test (DSST) is a component of the widely-used Weschler Adult Intelligence Scale (16), and measures processing speed and assesses function of working memory including the visuospatial sketchpad (14). It also measures sustained attention as a test of overall executive function (14) and demonstrates good test-retest reliability (14). Participants completed a response form, appropriately linking numbers to their assigned symbols, over a 90 second period. The number of correct number-symbol matches was recorded with a higher score indicating better performance. The Hopkins Verbal Learning Test Revised (The HVLT-R) is a test of verbal learning and verbal memory (17). The HVLT-R is comprised of a 12-word list of everyday objects read aloud to the

participant across three consecutive learning trials (18) and includes three scores: Total Recall - total number of words recalled correctly on trials 1-3; 2) Delayed Recall - number of words recalled correctly after a 20-25 minute delay; and 3) Recognition - number of true responses minus the number of false responses on a subsequent “yes/no” recognition task (18). The HVLT-R is a valid neuropsychological assessment for use in clinical and research settings with elderly patients (17).

The raw test scores were converted into age-adjusted standardized scores (z-scores) based on published normative data from healthy age-matched peers (7). We used a cut-off of 1.5 standard deviations (SD) below the age-adjusted means to identify impaired performance on a given cognitive measure (7). MCI was defined as an impairment (i.e. z-score < -1.5) on two or more sub-tests within the neuropsychological test battery (HVLT-R Total Recall, HVLT-R Delayed Recall, HVLT-R Recognition Discrimination, DSST, Trails A, and Trails B). All participants were identified as either cognitively intact (MCI-) or as having mild cognitive impairment (MCI+).

Measures of mobility—Two performance-based measures of mobility were used: Habitual Gait Speed (HGS) and the Short Physical Performance Battery (SPPB). Habitual Gait Speed is a reliable and valid measure of straight-path walking velocity (10) requiring participants to walk 4 meters in a straight line at their usual walking pace, starting from a standing position. The clinically meaningful difference for HGS has been reported to range from 0.03-0.05 meters/second as a minimal difference, to 0.08 m/s as a substantial difference (19). The SPPB is a valid and reliable measure of lower extremity function. Performance is predictive of disability and other adverse health outcomes among older adults (10,20). The SPPB combines scores from three subtests to create a composite score. Clinically meaningful difference for the SPPB ranges from 0.3-0.8 points (minimal change) to 0.8-1.5 points (substantial difference) (19). Subtests include assessments of standing balance, HGS, and the ability to rise from a chair repeatedly. Each subtest is measured on a 0-4 point scoring scale; the maximum total summed score is 12.

We utilized the Advanced and Basic Lower Extremity subdomains of the Late Life Function and Disability Index (LLFDI) to measure patient-reported mobility. The LLFDI a valid self-reported measure of physical functioning (21-23) that assesses functioning in a broad array of everyday activities, and queries participants on difficulties with performing 32 different activities (21). LLFDI scores are transformed to scaled scores (0-100); higher scores indicate better functioning (21). The basic lower extremity function (BLE) subdomain, includes such activities as ability to walk around the home, and contains 14 total items. The advanced lower extremity function (ALE) subdomain, comprises more advanced tasks, such as ability to hike several miles, and consists of 11 total items.

Adjustment Variables—Body Mass Index (BMI) was categorized as either obese (BMI ≥ 30), overweight (BMI = 25.0-29.9), or normal weight (BMI < 25). Total comorbidities were defined using a well-established and valid comorbidity questionnaire (24), and ranged from 1-13, with a higher score indicating more comorbid conditions. Participants were asked to bring all of the current medications and names, dosages, and dosing frequency of all medications and supplements were recorded. Medications were assigned eight-digit codes

according to class via the IowaBaseline pain medication (inclusive of both narcotic and non-narcotic analgesics.) use and psychoactive medication were defined as any medication used daily. Participants were assessed for depressive systems using the Patient Health Questionnaire, or PHQ-9 (30). Education was divided into four categories: Grade 11, Completed High School or GED, Completed College, and Graduate/Professional School. Due to the high prevalence of Whites, race was defined as either White or Non-White.

Statistical Analysis

Descriptive information was presented as means with standard deviations (SD) for continuous variables, and as frequencies with percentages for categorical variables, according to pain and MCI status. In order to investigate differences between the four groups (Pain-/MCI-, Pain+/MCI-, Pain-/MCI+, and Pain+/MCI+), we used analysis of covariance for continuous variables and chi-squared analysis for categorical variables.

Participants were sorted into four groups based on pain and MCI status. Using analysis of covariance, we examined difference in least squares means across all Pain/MCI groups and performed pair-wise comparisons when appropriate, using the Pain-/MCI- group as a reference group. An alpha value of 0.05 was used to determine statistical significance. Data were analyzed using SAS 9.3 (SAS Institute Inc., Cary, NC, US).

RESULTS

Baseline characteristics are presented in Table 1. Average age among the 430 participants was 76.6 (SD 7.0 years), and two-thirds of the cohort was female. Pain was present in 34%, and MCI was present in 42% of participants at baseline; 17% were found to be Pain+/MCI+, 41% were found to be Pain-/MCI-, 17% were found to be Pain+/MCI-, and 25% were found to be Pain-/MCI+.

Participants with Pain+/MCI+ performed significantly worse on all mobility measures (both physical performance and patient-reported functioning) than participants with Pain-/MCI- within both unadjusted and adjusted models (Table 2 and Figure 1). Participants with both conditions (Pain+/MCI+) performed more poorly than all other groups across all performance-based measures and self-reported function. Additionally, participants from the Pain+/MCI- group and the Pain-/MCI+ group performed more poorly than those with neither problem, but better than the Pain+/MCI+ group, across all outcomes. These findings were maintained within multivariable models. Post-hoc analyses were performed to assess for mediating effects of various subdomains of cognitive tests and depressive symptoms. The results of these analyses revealed that these factors were not significantly related to the outcome, and their inclusion did not significantly change the effect measures or alter the conclusions of these analyses.

DISCUSSION

To our knowledge, this is the first study to investigate the combined effects of pain and MCI on mobility outcomes among older adult primary-care patients. Poor mobility is recognized as a signal condition identifying older adults at increased risk for mortality and disability

(25). If primary care patients are screened for mobility limitations, it is important to understand the prevalence and impact of pain and MCI. Our major findings include: 1) Participants with Pain+/MCI+ consistently performed worse on performance-based and patient-reported measures of mobility than their participants with neither pain nor MCI and worse than those with either condition alone; and 2) the presence of either condition was associated with worse mobility status with all mobility outcomes. The presence of these conditions had an additive association with poorer mobility status. Our findings are consistent with previous studies illustrating important associations between MCI and physical performance measures, as well as pain and physical performance measures (1,4,26,27).

Our findings suggest that screening for mobility problems among older primary care patients will identify large percentages of individuals with pain and/or MCI. Second, the manifestation of these conditions will have an additive effect in being associated with worse mobility status.

Among our performance-based mobility measures (figure 1), the magnitude of differences between groups consistently met or exceeded previously defined thresholds for clinically meaningful differences (19). The increments of difference on the y-axis of each figure correspond to the threshold of a small clinically meaningful difference (19). HGS and SPPB scores were lower with the presence of pain, and even more so with the addition of MCI. Clinically meaningful differences are not defined for the BLE and ALE subcomponents of the LLFDI.

This study is cross-sectional and accordingly findings do not imply causality. While our study is not population-based, our sample reflects the demographic distribution of older adults living in the Boston area. The BPI is a general survey of pain status and cannot elucidate common pain generators or sites of pain. This study does not include a measure of anxiety. Study strengths include: 1) use of well-established and valid definitions of pain and MCI; 2) a well-characterized cohort of older adult primary care patients; and 3) the utilization of state-of-the-art mobility measurement tools. Furthermore, our study considers both physical performance measures and self-reports of physical functioning—a critical combination that has been demonstrated to assess a larger scope of an individual's functioning than performance-based measures alone (28). It is notable that only 2 of our participants were actively taking opioid pain medication, and thus narcotic use cannot be attributed as a major contributor to our findings. Additionally, because our cohort represents a group of older adults at risk for mobility decline, and mobility decline has been separately linked to MCI, the prevalence of MCI in our study was higher than the prevalence within population-based samples (7,25). Thus, our study highlights that if mobility screening is to be employed in primary care, both pain and/or MCI may also be prevalent among these individuals.

Primary care guidelines for patients with mobility problems do not exist. A clinical review in JAMA on the management of mobility limitations among older adults did not prioritize pain or MCI, since their strong relationship to mobility had not yet been established (29). However, rehabilitation is dependent upon a patient's capacity to learn, and therefore

impaired cognitive function is an important characteristic that may influence the course of care. Similarly, the concomitant presence of significant pain problems will add a second focus contributing to the complexity of care. Primary care providers are uniquely positioned to recognize the coexistence of MCI, pain, and mobility problems, and make decisions regarding appropriate course of care for these patients.

Conclusions

There is a high prevalence of both pain and mild cognitive impairment among older community-dwelling primary care patients at risk for mobility decline. Those manifesting only pain or only cognitive impairment performed worse on a wide variety of mobility measures than those with neither of these two conditions. Additionally, the presence of both pain and cognitive impairment was found to have additive associations with poorer mobility performance. These relationships highlight the importance of both MCI and pain within primary care screenings and care paradigms.

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Figure 1.

Unadjusted analyses of covariance illustrating associations between Pain/MCI status and measures of performance-based mobility on 1a) Short Physical Performance Battery (SPPB) and 2b) Habitual Gait Speed. Both models with $p < .001$. Error bars represent standard deviation. Numeric values represent mean $\pm$ standard deviation.

Note: incremental units on y-axis represent the clinically meaningful difference (SPPB: 0.5 points; HGS: 0.05 m/s).

Note: MCI=Mild Cognitive Impairment; + = condition present, - = condition absent.

Table 1

Descriptive information characterizing the Boston RISE^{*} cohort (N=430) by Pain/MCI group.

Characteristics	Pain-/MCI- N=176 (40.9%)	Pain+/MCI- N=73 (17.0%)	Pain-/MCI+ N=108 (25.1%)	Pain+/MCI+ N=73 (17.0%)	P value
N(%) or mean(SD)					
Age	77.0 (6.5)	75.3 (7.0)	77.3 (7.4)	75.7 (7.5)	0.75
Female	115 (65.3)	57 (78.1)	68 (63.0)	51 (69.9)	0.15
White	162 (92.1)	64 (87.7)	83 (76.9)	46 (63.0)	<0.001
BMI 30 (obese)	58 (33.1)	34 (46.6)	36 (33.3)	32 (43.8)	0.37
25.0-29.9 (overweight)	70 (40.0)	25 (34.3)	46 (42.6)	26 (35.6)	
18.5-24.9 (normal weight)	47 (26.9)	14 (19.2)	26 (24.1)	15 (20.6)	
Education: Grade 11	9 (5.1)	8 (11.0)	15 (13.9)	22 (30.1)	<0.001
Completed High School or GED	41 (23.3)	21 (28.8)	40 (37.0)	28 (38.4)	
Completed College	64 (36.4)	30 (41.1)	31 (22.1)	15 (20.6)	
Graduate/Professional School	62 (35.2)	14 (19.2)	22 (20.4)	8 (11.0)	
Comorbidity Score (range: 0-11)	3.8 (1.7)	4.6 (2.1)	3.5 (1.8)	4.7 (1.7)	0.001
Pain medication use ^{**}	135 (77.6)	62 (84.9)	83 (76.9)	61 (83.6)	0.40
Psychoactive medication use ^{***}	46 (26.1)	27 (37.0)	42 (38.9)	31 (42.5)	0.27

MCI+ = Mild Cognitive Impairment; MCI- = No Mild Cognitive Impairment

^{*} Boston RISE = Boston Rehabilitative Impairment of the Elderly.

^{**} Defined as use of 1 pain medications of either narcotic or non-narcotic origin.

^{***} Defined as use of 1 psychoactive medication.

Table 2

Analyses of covariance results showing the association between Pain/MCI status and scores on the advanced and basic lower extremity function subdomains of the Late Life Function & Disability Instrument (LLFDI), total Short Performance Physical Battery (SPPB) score, and habitual gait speed.

Outcome % (SD)	Pain-/MCI- N=176 (40.9%)	Pain+/MCI- N=73 (17.0%)	Pain-/MCI+ N=108 (25.1%)	Pain+/MCI+ N=73 (17.0%)	P value
Basic lower extremity function score, LLFDI (range: 0-100)	69.7 (11.3)	63.2 (10.0)	66.8 (13.0)	58.3 (10.2)	<0.001
Advanced lower extremity function score, LLFDI (range: 0-100)	45.5 (12.9)	41.0 (15.7)	40.7 (15.2)	34.9 (14.5)	<0.001
Total SPPB score (range: 4-12)	9.4 (2.1)	8.9 (2.1)	8.1 (2.3)	7.6 (2.3)	<0.001
Habitual gait speed (range: 0.3-1.5) (m/s)	0.97 (0.18)	0.93 (0.23)	0.86 (0.22)	0.77 (0.18)	<0.001

Note: Models adjusted for age, gender, BMI, education, race, pain medications, psychoactive medications, depressive symptoms, and total comorbidities.

MCI=Mild Cognitive Impairment; + = condition present, - = condition absent.