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Pain Characteristics Associated with the Onset of Disability in Older Adults: The Maintenance of Balance, Independent Living, Intellect, and Zest in the Elderly Boston Study

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Pain Characteristics Associated with the Onset of Disability in Older Adults: The Maintenance of Balance, Independent Living, Intellect, and Zest in the Elderly Boston Study

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OBJECTIVES: To determine the effects of chronic pain on the development of disability and decline in physical performance over time in older adults.

DESIGN: Longitudinal cohort study with 18 months of follow-up.

SETTING: Urban and suburban communities.

PARTICIPANTS: Community-dwelling older adults aged 65 and older (N = 634).

MEASUREMENTS: Chronic pain assessment consisted of musculoskeletal pain locations and pain severity and pain interference according to the subscales of the Brief Pain Inventory. Disability was self-reported as any difficulty in mobility and basic and instrumental activities of daily living (ADLs, IADLs). Mobility performance was measured using the Short Physical Performance Battery (SPPB). Relationships between baseline pain and incident disability in 18 months were determined using risk ratios (RRs) from multivariable Poisson regression models.

RESULTS: Almost 65% of participants reported chronic musculoskeletal pain at baseline. New onset of mobility difficulty at 18 months was strongly associated with baseline pain distribution: 7% (no sites), 18% (1 site), 24% (multisite), and 39% (widespread pain, *P*-value for trend < .001). Similar graded effects were found for other disability measures. Elderly adults with multisite or widespread pain had at a risk of onset of mobility difficulty at least three times as great as that of their peers without pain after adjusting for disability risk factors (multisite pain: risk ratio (RR) = 2.95, 95% confidence interval (CI) 1.58–5.50; widespread pain: RR = 3.57, 95% CI = 1.71–7.48). Widespread pain contributed to decline in mobility performance (1-point decline in SPPB, RR = 1.47, 95% CI = 1.08–2.01). Similar associations were found for baseline pain interference predicting subsequent mobility decline and ADL and IADL disability. Weaker and less-consistent associations were observed with pain severity.

CONCLUSION: Older community-dwelling adults living with chronic pain in multiple musculoskeletal locations have a substantially greater risk for developing disability over time and for clinically meaningful decline in mobility performance than those without pain. **J Am Geriatr Soc 62:1007–1016, 2014.**

Key words: widespread chronic pain; older adults; mobility limitation; activities of daily living

Chronic pain is common in older adults[1] and is associated with several negative health outcomes, including cognitive deficits[2] and falls.[3] Highly prevalent, painful conditions such as osteoarthritis are related to mobility limitations and functional disability in older adults.[4,5] Accumulating evidence, primarily from cross-sectional studies, links pain and mobility problems, with most studies reporting pain in selected sites being associated with impairments in balance and gait.[4,6] Several studies have linked site-specific pain, including hip or knee pain[7] and low back pain,[8] to functional disability.

Similarly, in the clinical setting, pain treatment is typically focused on selected pain sites directly related to specific conditions such as knee osteoarthritis, whereas chronic pain in older persons is most commonly a multisite or generalized condition.[9,10] As reported previously, 62%

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of participants in the Maintenance of Balance, Independent Living, Intellect, and Zest in the Elderly (MOBILIZE) Boston Study who had musculoskeletal pain reported pain in two or more sites.[3] Longitudinal studies, using global pain assessments, have recently found associations between chronic pain and subsequent greater risk of mobility decline and disability in selected groups of elderly adults; these studies included older adults in religious orders, residents of retirement communities, older women with disabilities, and individuals receiving home care.[11–14] Nonetheless, the lack of generalizability of the findings or limited pain assessments have limited studies. The economic burden of disability is clear in terms of healthcare resources and caregiver and societal burden.[15,16] The accumulating research published on this topic reflects the growing concern about the effect of chronic pain in the lives of older adults.[17–19] If the functional effect of chronic pain in older adults is a progressive problem whereby chronic pain leads to deteriorating function over time, the need for effective long-term management of chronic pain conditions will have growing urgency, especially with the rapid growth of the older population in coming decades. It was hypothesized that chronic musculoskeletal pain would contribute to the onset of physical disability in older adults. The present study aimed to prospectively examine the association between multiple domains of chronic pain and subsequent self-reported and observed disability in a population-based cohort of older adults.

METHODS

Participants

The MOBILIZE Boston Study is a longitudinal population-based study of older community-living adults.[20] Participants, enrolled from 2005 to 2008, live in Boston and surrounding suburbs. Potential participants were randomly sampled from town lists and recruited door to door. Criteria for study participation included aged 70 and older, able to speak and read English, able to walk independently across a small room, and plan to remain in the area for at least 2 years. Spouses or domestic partners of eligible participants could join the study if they were within 6 months of their 65th birthday or older and met eligibility criteria. People were excluded if they had a terminal disease or cognitive impairment. Baseline assessment included a home visit by a trained research assistant followed by a nurse examination at the study clinic. During the home visit, participants provided informed consent and were screened for moderate to severe cognitive impairment based on a score of 17 or lower on the Mini-Mental State Examination.[21] The assessments were repeated approximately 18 months after baseline. Further details of the study design and methods have been published previously.[20] The institutional review boards of Hebrew SeniorLife, University of Massachusetts Boston, and Beth Israel Deaconess Medical Center approved all study procedures.

Chronic Pain Assessment

Chronic musculoskeletal pain was assessed according to pain distribution, severity, and interference with daily activities. Pain distribution was determined using a 14-item questionnaire (Appendix 1) ascertaining pain in major musculoskeletal sites (back, chest, shoulder, hand, wrist, hip, knee, foot) lasting 3 or more months in the previous year and present in the previous month.[9,22] Pain assessment did not include laterality, so pain in one or both knees was counted as one site of pain. Chest pain was excluded if associated with angina pectoris, measured using the Rose Angina questionnaire[23] or use of nitrates recorded in the medication inventory. Responses were categorized into four groups: no pain, single-site pain, more than one pain site (multisite pain) but not meeting criteria for widespread pain, and widespread pain. Criteria for widespread pain were pain above and below the waist and axial skeletal pain (back or nonanginal chest pain). Because laterality was not included, this is a modification of the widespread pain classification by the American College of Rheumatology (ACR).[22]

Pain severity was measured using the pain severity subscale of the Brief Pain Inventory (BPI), a validated questionnaire for individuals with chronic musculoskeletal conditions.[24,25] This instrument assesses global pain severity and is recommended for use in older adults.[23] Participants rated their pain in the past week according to four conditions (at its worst, at its least, on average, and now), referring to an 11-point numeric rating scale, with 0 indicating no pain and 10 indicating severe or excruciating pain as bad as you can imagine. The severity score was based on the average of the four item ratings and categorized into quartiles (<0.5, 0.5–1.74, 1.75–3.71, ≥3.71); the fourth quartile indicating moderate to severe pain.

Pain interference with daily activities was measured using a seven-item subscale of the BPI addressing general activity, mood, walking, normal work including housework, relationships with others, sleep, and enjoyment of life. Participants rated pain interference with each activity from 0 (does not interfere at all) to 10 (completely interferes).[24] The average score of the seven ratings was categorized into quartiles (<.01, 0.1–0.56, 0.57–2.56, ≥2.57).

Assessment of Disability and Performance Outcomes

Three domains of self-reported disability were assessed at baseline and follow-up: mobility in walking (walking for one-quarter of a mile, ~2 or 3 blocks) and stair-climbing (walking up 10 steps, or 1 flight of stairs), activities of daily living (ADLs; bathing, dressing, transferring, using the toilet, and eating), and instrumental activities of daily living (IADLs; shopping, preparing meals, and light and heavy housework).[23] Response options were to identify level of difficulty in performing (none, a little, some, a lot) or inability to perform each activity. Incident disability was defined as report of any difficulty in one or more tasks within a disability domain at the follow-up assessment in persons who had no difficulty in the specific domain at baseline.

Mobility performance was measured using the well-validated Short Physical Performance Battery (SPPB),[26] which comprises three sets of lower body mobility tests: gait speed, standing balance, and repeated chair stands. Gait speed was assessed as the faster of two trials of a timed usual-pace 4-m walk. Standing balance was assessed in three 10-second stands: standing with feet side by side,

semitandem stand with the side of the heel of one foot touching the side of the big toe of the other foot, full tandem (heel to toe) stand. Timed repeated chair stand tests measured the ability and time required to stand up from and sit down in a chair as fast as possible five times with the arms folded across the chest. The SPPB was scored using the standard scoring protocol, ranging from of 0 to 12, and was calculated from the sum of categorical scores on the three tests, each ranging from 0 to 4.[26] Higher values indicate better function. Decline in SPPB score was measured by subtracting the follow-up score from the baseline score.

Covariates

Several potential confounders of the association between chronic pain and disability were assessed at baseline. Demographic characteristics included age, sex, race, and education. Body mass index (BMI) was determined using measured weight in kilograms divided by height in squared meters. The MMSE was used to assess global cognitive functioning,[21] and the Physical Activity Scale for the Elderly (PASE) was used to quantify level of physical activity in the previous 7 days.[27]

Comorbidity

Participants were asked whether a physician had told them they had heart disease (myocardial infarction, atrial fibrillation, pacemaker, angina pectoris, or congestive heart failure), rheumatoid arthritis, Parkinson's disease, asthma or lung disease, or stroke. Peripheral neuropathy was assessed using the Semmes Weinstein monofilament test.[28] Diabetes mellitus was assessed using an algorithm based on self-reported diabetes mellitus, use of oral hypoglycemics or insulin, and laboratory measures including random glucose (≥200 mg/dL, to convert to mmol/L, multiply by 0.0555) and glycosylated hemoglobin (>7%). The study rheumatologist (RS) trained nurses to assess osteoarthritis of the hand and knee according to ACR clinical criteria.[23] Presence of depressive symptoms was determined based on the Hopkins Revision of the Center for Epidemiologic Studies Depression Scale.[29]

Medication Use

Use of prescription and over-the-counter medications in the previous 2 weeks was determined using information recorded from medication bottles during the home interview. Medication codes were applied to each medication using the Iowa Drug Classification System.[30] Analgesic medications included opioid and nonopioid analgesics and were classified according to daily use versus other or no use. Psychotherapeutic drugs included sedative, hypnotic, anxiolytic, antidepressant, and antipsychotic medications. Use of psychotherapeutics was summarized into four groups (no use, nondaily use, use of 1 medication at least daily, daily use of ≥2 different medications).

Statistics

Descriptive statistics were used to examine sociodemographic and health characteristics of the study cohort according to pain distribution. Linear trends across pain categories were determined using chi-square tests (1 degree of freedom). Incident mobility and ADL and IADL difficulty and clinically meaningful SPPB decline (1 point)[31] were examined according to the three pain measures and compared using chi-square tests. Relationships between baseline pain and onset of disability and physical performance outcomes at the 18-month follow-up were determined using risk ratios (RR) derived from Poisson regression modeling with robust error variances and adjusted for potential confounders.[32] Using data from the hand and knee osteoarthritis assessment, the presence of the nonpain osteoarthritis criterion was adjusted for, because including the pain criterion would have been an overadjustment in the models. To study incident disability in each of the three domains, models were constructed including only people with no disability in the specific domain at baseline. With respect to the physical performance outcome, persons with a very low SPPB score (≤3) at baseline were excluded. Models generated multivariable-adjusted RRs and 95% confidence intervals (CIs). The three different domains of baseline chronic pain were separately investigated in relation to disability outcomes: pain distribution (none, single site, multisite, widespread according to a modification of the ACR criteria), pain severity (quartiles of the BPI pain severity subscale), and pain interference (quartiles of the BPI interference subscale). Multiple pain measures were not included in the same models because the measures were highly correlated (correlation coefficient > 0.53). Separate analyses were run using pain severity and pain interference tertiles, quartiles, and quintiles. The population attributable risk percentage (PAR%) for new mobility difficulty and IADL difficulty related to multisite (including widespread) pain was calculated (using the formula: (total incidence–incidence in the unexposed (people with no pain or single site pain))/total incidence × 100%). Analyses determining change of pain distribution category over time in relation to disability outcomes was also performed using four categories (no change (no pain or single site pain at baseline and no pain or single site pain at follow-up), change from multisite pain at baseline to no pain or single site pain at follow-up, change from no pain or single site pain at baseline to multisite pain at follow-up, multisite pain at baseline and multisite pain at follow-up (persistent multisite pain)). Last, separate Poisson regression models were constructed to determine the relationship between specific pain sites (back, hand, hip, knee, and foot) and subsequent disability. Data were analyzed using SPSS version 16 (SPSS Inc., Chicago, IL).

RESULTS

Mean age of participants at baseline was 78 ± 5 (range 64–97), 64% of participants were female, and 19% were nonwhite, largely representative of older adults in the Boston area according to the 2000 U.S. Census. Of the 765 people who completed the baseline assessment, 21 (3%) died, and 84 (11%) dropped out before the 18-month follow-up assessment, with main reasons for withdrawal being unable to continue because of illness (n = 24, 29% of those dropping out) or decided not to continue in the study (n = 20, 24% of those dropping out).

Older persons who had more sites of pain were significantly more likely to be female; have fewer years of education, higher BMI, poorer cognitive function (lower MMSE score), rheumatoid arthritis, lung disease, hand or knee osteoarthritis, or depression; and more likely to use psychotherapeutic or analgesic medication daily (Table 1). Persons with widespread pain were more likely to be female, and have fewer years of education, lower MMSE scores, and higher prevalence of obesity (45%) than the other pain groups. Persons with multisite or widespread pain at baseline also had significantly more difficulty with respect to mobility, ADLs, and IADLs, and a larger percentage had an SPPB score of 9 or lower (Table 1).

Of the 634 people who completed the follow-up assessment (mean 15.8 ± 2.2 months), almost 65% reported chronic musculoskeletal pain at baseline. Almost 40% reported multisite or widespread pain at baseline, and 67% of those continued to report multisite or widespread pain at follow-up. Significant trends were observed for incident disability across all outcomes according to each of the three pain domains at baseline over the 18-month follow-up (Figure 1A–C). The onset of new mobility difficulty at 18 months according to baseline pain distribution was 7% for no sites, 18% for one site, 24% for multisite, and 39% for widespread pain (*P*-value for trend < .001). Similar graded effects were observed for ADL and IADL disability. SPPB decline at 18 months according to pain distribution was 32% for no sites, 46% for one site, 36% for multisite, and 49% for widespread pain (*P*-value for trend < .05). Similar strong associations were found between baseline pain severity and ADL and IADL disability and SPPB decline (Figure 1B) and pain interference in relation to ADL and IADL disability (Figure 1C) but not SPPB decline (*P*-value for trend = .08) at the 18-month follow-up.

Participants with multisite pain had three times the risk of onset of self-reported mobility difficulty adjusted for age, sex, race, education, BMI, cognitive function, comorbid conditions, level of physical activity, daily analgesic use, and number of psychotherapeutic medications as their counterparts with no pain (RR = 2.95, 95% CI = 1.58–5.50) and of widespread pain versus no pain (RR = 3.57, 95% CI = 1.71–7.48) (Table 2). There was also more than twice the risk of incident IADL difficulty for those with multisite pain (RR = 2.1, 95% CI = 1.4–3.3) and those with widespread pain (RR = 2.7, 95%

Table 1. Baseline Participant Characteristics According to Pain Distribution (N = 633)

Characteristic	No Pain, n = 227	Single-Site Pain, n = 157	Multisite Pain, n = 166	Widespread Pain, n = 83[a]	*P*-Value[b]
Age, mean ± SD	77.7 ± 5.3	77.8 ± 5.4	77.7 ± 5.5	78.6 ± 4.9	.34
Education, years, mean ± SD	14.6 ± 2.9	14.7 ± 3.0	14.1 ± 3.2	13.6 ± 3.3	.003
Mini-Mental State Examination score, mean ± SD	27.5 ± 2.5	27.4 ± 2.3	27.2 ± 2.5	26.6 ± 2.9	.01
Physical Activity Scale for the Elderly score, mean ± SD	115.0 ± 67.1	110.2 (74.0)	102.2 ± 64.5	107.3 ± 64.9	.12
Female, n (%)	135 (60)	90 (57)	118 (71)	64 (77)	.001
White, n (%)	182 (80)	123 (78)	123 (74)	62 (76)	.18
Obese (body mass index ≥30.0 kg/m^2), n (%)	51 (23)	44 (28)	45 (27)	37 (45)	.001
Peripheral neuropathy, n (%)	22 (10)	15 (10)	22 (13)	12 (15)	.13
Heart disease, n (%)	82 (36)	73 (47)	79 (48)	31 (37)	.25
Diabetes mellitus, n (%)	22 (10)	22 (14)	23 (14)	12 (15)	.18
Rheumatoid arthritis, n (%)	6 (3)	5 (3)	13 (8)	5 (6)	.03
Lung disease, n (%)	18 (8)	20 (13)	36 (22)	18 (22)	<.001
Stroke, n (%)	19 (8)	15 (10)	15 (9)	9 (11)	.57
Hand osteoarthritis, n (%)[c]	85 (37)	50 (32)	76 (46)	43 (52)	.008
Knee osteoarthritis, n (%)[c]	105 (46)	80 (51)	99 (60)	53 (64)	.001
Depressed, n (%)[d]	9 (4)	7 (5)	20 (12)	9 (11)	.001
Daily analgesic use, n (%)[e]	28 (12)	35 (22)	54 (33)	34 (41)	<.001
Daily psychotherapeutic drugs, n (%)[f]	26 (11)	21 (13)	20 (12)	23 (28)	.005
Any baseline mobility difficulty, n (%)	42 (19)	39 (25)	80 (48)	46 (58)	<.001
Any baseline activity of daily living difficulty, n (%)	26 (11)	25 (16)	50 (30)	33 (40)	<.001
Any baseline instrumental activity of daily living difficulty, n (%)	49 (22)	57 (36)	84 (51)	52 (63)	<.001
Baseline Short Physical Performance Battery score ≤9	43 (19)	34 (22)	63 (38)	35 (42)	<.001

One person had missing data with respect to the pain distribution variable.

SD = standard deviation.

[a]Classified according to a modification of the criteria of the American College of Rheumatology that did not include laterality.

[b]Test for linear trend across categories of pain distribution.

[c]Determined according to clinical criteria of the American College of Rheumatology.

[d]Measured using the Centers for Epidemiologic Studies Depression scale.

[e]Use of ≥1 analgesic medications at least daily in the previous 2 weeks.

[f]Use of ≥1 psychotherapeutic medications at least daily in the previous 2 weeks.

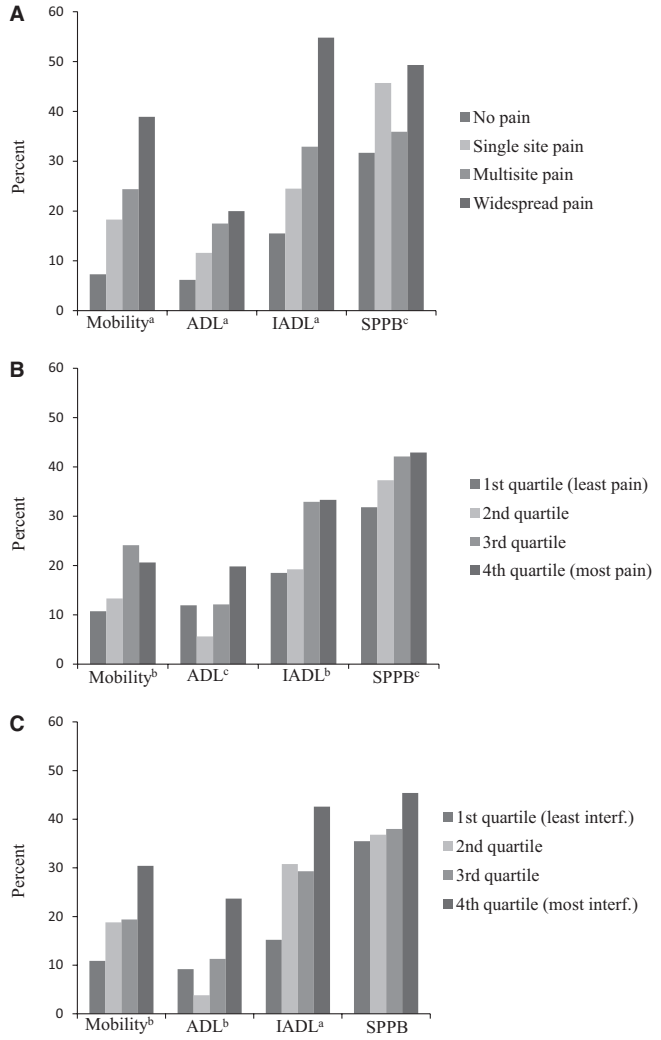

Figure 1. Onset of self-reported mobility difficulty, activity of daily living (ADL) difficulty, instrumental activity of daily living (IADL) difficulty, and clinically meaningful Short Physical Performance Battery (SPPB) decline in 18 months according to (A) baseline pain distribution category, (B) baseline pain severity quartile, and (C) baseline pain distribution category. Chi-square test for trend $P <$ [a].001, [b].01, [c].05.

CI = 1.6–4.5) as for those with no pain, after adjusting for the same potential confounders (Table 2). For SPPB decline, single-site and widespread pain were each associated with decline in performance (RR = 1.5, 95% CI = 1.1–2.0 for widespread pain vs no pain) (Table 2). Similar associations were found for pain interference contributing to mobility difficulty, ADL difficulty, and declining mobility performance (Table 2). Any report of pain interference was associated with at least twice the risk of IADL difficulty as no pain interference (Table 2). No consistent relationship was observed between pain severity and disability outcomes after adjusting for other risk factors (Table 2). Results were similar when using tertiles or quintiles of pain severity and interference (data not shown). In these multivariable analyses, 18 persons were missing outcome or covariate information; they did not differ according to participant characteristics from those with complete information.

Additional adjustment for the presence of nonpain hand and knee osteoarthritis criteria did not influence the relationships between pain characteristics and incident disability, nor were these nonpain factors independently associated with incident disability (data not shown). No interactions were seen between pain distribution and pain severity in relation to the disability or performance outcomes (data not shown).

To estimate the burden of disability related to multisite and widespread pain, it was determined that the PAR % for new mobility difficulty related to multisite (including widespread) pain was 51%, and similarly, the PAR% for onset of IADL difficulty was 46%. In other words, multisite and widespread musculoskeletal pain combined at baseline contributed to (almost) half of all new reports of mobility and IADL difficulty at the 18-month follow-up. Similarly, in terms of the effect of change in pain distribution over time, it was the persistence of multisite pain over time that was associated with greater risk of self-reported mobility difficulty and difficulty in performance of ADLs and IADLs. Change from no sites or single-site pain at baseline to more sites of pain at follow-up was not associated with disability risk (Table 3).

When the effect of site-specific pain on risk of incident disability was examined, hip and knee pain regardless of co-occurring pain in other sites were each independently associated with risk of incident mobility difficulty (Table 4). Single-site back, hip, and knee pain were each also associated with clinically meaningful SPPB decline (Table 4). In general, single-site pain was a rarity in the cohort, and persons with multisite pain, regardless of the sites involved, consistently had greater risk of onset of disability (Table 4).

DISCUSSION

In this population of older community-dwelling adults, chronic pain measured in three global domains was strongly associated with a high risk of incident disability after 18 months, adjusting for several potential confounders. Although associations were found between selected site-specific pain and disability risk, multisite pain was most consistently related to disability onset. Chronic pain is highly prevalent in the older population and leads to tremendous burden on individuals and society.[1,15,16] Although clinicians may view chronic pain as a "steady state" in older adults, the findings of the current study suggest that it may contribute to progressive disability over time. These results consistently showed that pain distribution and pain interference are the best predictors of mobility difficulty, ADL and IADL difficulty, and clinically meaningful decline in mobility performance. Global pain severity did not show similar or consistent relationships. It could be that severity alone does not capture the heterogeneity of the problem of pain in older adults. Although global measures of pain are correlated, severity and pain distribution do not measure the same characteristic; persons may have more-localized pain that is more severe but not as disabling as more-disseminated pain. Previous cross-sectional studies have shown that pain distribution is more strongly associated with disability and worse mobility than pain severity.[14,33] Also, in a recent longitudinal study, pain

Table 2. Risk of Onset of Self-Reported Mobility Difficulty, Difficulty in Performance of Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living (IADLs), and Clinically Meaningful Decline in Short Physical Performance Battery (SPPB) Score According to Pain Measures in Adults Aged 70 and Older: MOBILIZE Boston Study

	Mobility Difficulty		ADL Difficulty		IADL Difficulty		SPPB Decline (1 Point)	
Pain Category	N[a]	RR (95% CI)[b]	N[a]	RR (95% CI)[b]	N[a]	RR (95% CI)[b]	N[c]	RR (95% CI)[b,d]
Pain distribution								
No pain	177	1.0	194	1.0	174	1.0	217	1.0
One pain site	114	1.88 (0.97–3.64)	128	1.76 (0.79–3.88)	98	1.25 (0.77–2.03)	149	1.34 (1.04–1.74)
Multisite pain	86	2.95 (1.58–5.50)	111	3.63 (1.78–7.41)	79	2.14 (1.37–3.34)	147	1.10 (0.82–1.48)
Widespread pain[e]	36	3.57 (1.71–7.48)	48	2.25 (0.90–5.64)	30	2.69 (1.61–4.50)	73	1.47 (1.08–2.01)
BPI pain severity[e]								
Q1 (least pain, <0.5)	121	1.0	134	1.0	119	1.0	148	1.0
Q2 (0.5–1.74)	113	1.50 (0.77–2.90)	125	0.50 (0.21–1.22)	104	1.26 (0.75–2.13)	141	1.27 (0.92–1.74)
Q3 (1.75–3.71)	115	2.00 (1.13–3.55)	130	1.03 (0.55–1.93)	83	1.89 (1.16–3.08)	156	1.26 (0.94–1.70)
Q4 (most pain, >3.71)	62	1.70 (0.81–3.57)	91	1.66 (0.87–3.16)	73	1.64 (0.99–2.73)	140	1.33 (0.95–1.85)
BPI pain interference[f]								
Q1 (least interference, <.01)	201	1.0	217	1.0	184	1.0	234	1.0
Q2 (0.1–0.56)	48	1.95 (0.98–3.88)	53	0.47 (0.12–1.93)	39	2.19 (1.24–3.86)	57	1.16 (0.80–1.69)
Q3 (0.57–2.57)	107	2.01 (1.34–3.55)	121	1.29 (0.65–2.56)	98	2.22 (1.43–3.45)	159	1.09 (0.84–1.41)
Q4 (most interference, >2.57)	55	2.46 (1.34–4.54)	89	2.74 (1.51–4.96)	58	2.56 (1.55–4.22)	134	1.32 (1.00–1.74)

[a]Analyses included only people without any disability at baseline (no mobility difficulty (n = 426) and no IADL difficulty (n = 391)).
[b]Risk ratios (RRs) and 95% confidence intervals (CIs) generated from multivariable Poisson regression with robust variance estimators predicting onset of disability or physical performance decline adjusted for age, sex, race, education, body mass index, cognitive function (Mini-Mental State Examination), comorbid conditions (neuropathy, heart disease, diabetes mellitus, rheumatoid arthritis, asthma or lung disease, stroke, depression), level of physical activity (Physical Activity Scale for the Elderly score), daily analgesic use, and number of psychotherapeutic medications.
[c]Analyses included 608 (persons with SPPB score of ≤3 were excluded).
[d]Baseline physical performance was also adjusted for in the SPPB analyses.
[e]Widespread pain was classified according to a modification of the criteria of the American College of Rheumatology that did not include laterality.
[f]Pain severity and pain interference subscales of the Brief Pain Inventory (BPI), each scored from 0 to 10.

Table 3. Risk of Onset of Self-Reported Mobility Difficulty, Difficulty in Performance of Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living (IADLs), and Clinically Meaningful Decline in Short Physical Performance Battery (SPPB) Score According to Change in Distribution of Pain over Time in Adults Aged 70 and Older: MOBILIZE Boston Study

	Mobility Difficulty		ADL Difficulty		IADL Difficulty		SPPB Decline (1 Point)	
Change in Pain Distribution	N[a]	RR (95% CI)[b]	N[a]	RR (95% CI)[b]	N[a]	RR (95% CI)[b]	N[c]	RR (95% CI)[b,d]
No pain, single site → no pain, single site	250	1.0	276	1.0	237	1.0	310	1.0
Multisite pain → no pain, single site	53	1.08 (0.87–2.42)	63	2.10 (1.00–4.39)	47	1.60 (0.92–2.76)	78	0.97 (0.69–1.36)
No pain, single site → multisite pain	44	1.12 (0.48–2.59)	48	0.82 (0.23–2.91)	35	1.40 (0.78–2.52)	57	1.17 (0.84–1.64)
Persistent multisite pain	69	3.07 (1.98–4.77)	101	2.39 (1.32–4.33)	66	2.72 (1.86–3.97)	149	1.17 (0.91–1.52)

[a]Analyses included only people without any disability at baseline (no mobility difficulty (n = 426) and no IADL difficulty (n = 391)).
[b]Risk ratios (RRs) and 95% confidence intervals (CIs) generated from multivariable Poisson regression with robust variance estimators predicting onset of disability or physical performance decline adjusted for age, sex, race, education, body mass index, cognitive function (Mini-Mental State Examination), comorbid conditions (neuropathy, heart disease, diabetes mellitus, rheumatoid arthritis, asthma or lung disease, stroke, depression), level of physical activity (Physical Activity Scale for the Elderly score), daily analgesic use, and number of psychotherapeutic medications.
[c]Analyses included 608 (persons with SPPB score of ≤3 were excluded).
[d]Baseline physical performance was also adjusted for in the SPPB analyses.

severity was not a significant predictor of a combined outcome of disability and death in an older population after controlling for confounders.[34]

A number of possible explanations for the relationship between pain and disability can be considered. One explanation lies in the neuromuscular effects of pain. People with pain may experience unfavorable neuromuscular adaptations to preserve function.[35] Neuromuscular changes during movement have been reported in older people with lower back pain[36] and people with widespread pain.[37] For example, chronic back pain may contribute to weakness in major muscles involved in trunk stability,

Table 4. Adjusted Risk Ratios (RR) for Onset of Mobility Difficulty, Difficulty in Performance of Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living (IADLs), and Clinically Meaningful Decline in Short Physical Performance Battery (SPPB) Score According to Specific Pain Sites: MOBILIZE Boston Study, 2005–2008

	Mobility Difficulty		ADL Difficulty		IADL Difficulty		SPPB Decline (1 Point)	
Pain Category	N[a]	RR (95% CI)[b]	N[a]	RR (95% CI)[b]	N[a]	RR (95% CI)[b]	N[c]	RR (95% CI)[b,d]
Back and other joint pain								
None	176	1.00	193	1.00	174	1.00	216	1.00
Pain other than back	154	2.17 (1.18–3.99)	183	2.27 (1.12–4.63)	146	1.55 (1.01–2.37)	230	1.19 (0.92–1.53)
Back only	15	1.74 (0.42–7.11)	20	2.42 (0.68–8.64)	8	1.37 (0.39–4.83)	20	1.61 (1.04–2.49)
Back and other pain	67	3.30 (1.72–6.33)	84	2.80 (1.26–6.21)	53	2.51 (1.59–3.94)	119	1.44 (1.09–1.90)
Hand or wrist and other joint pain								
None	176	1.00	193	1.00	173	1.00	216	1.00
Pain other than hand or wrist	151	2.22 (1.20–4.08)	189	2.23 (1.09–4.53)	132	1.49 (0.96–2.30)	224	1.36 (1.07–1.73)
Hand or wrist only	19	0.62 (0.08–4.98)	18	1.11 (0.16–7.57)	18	0.93 (0.37–2.31)	23	0.63 (0.30–1.35)
Hand or wrist and other pain	66	3.67 (1.96–6.88)	80	3.19 (1.47–6.94)	57	2.89 (1.84–4.54)	122	1.27 (0.94–1.70)
Hip and other joint pain								
None	177	1.00	194	1.0	174	1.00	217	1.00
Pain other than hip	189	1.95 (1.06–3.57)	228	2.15 (1.06–4.35)	165	1.52 (1.00–2.30)	278	1.27 (1.00–1.60)
Hip only	10	4.46 (1.68–11.83)	9	4.17 (1.10–15.87)	6	2.07 (0.67–6.39)	9	1.95 (1.10–3.47)
Hip and other pain	36	4.84 (2.33–10.04)	49	3.52 (1.46–8.49)	36	2.94 (1.79–4.85)	81	1.24 (0.89–1.73)
Knee and other joint pain								
None	177	1.00	194	1.0	174	1.00	217	1.00
Pain other than knee	144	2.09 (1.13–3.86)	160	2.02 (0.95–4.31)	114	1.81 (1.19–2.76)	194	1.28 (0.99–1.66)
Knee only	27	2.74 (1.06–7.10)	35	1.56 (0.49–4.98)	30	1.14 (0.53–2.45)	46	1.48 (1.06–2.07)
Knee and other pain	65	3.27 (1.67–6.36)	91	3.72 (1.77–7.83)	63	2.04 (1.23–3.37)	128	1.24 (0.93–1.66)
Feet and other joint pain								
None	177	1.00	194	1.0	174	1.00	217	1.00
Pain other than feet	157	2.21 (1.22–4.02)	187	2.82 (1.13–4.63)	144	1.80 (1.19–2.72)	237	1.34 (1.05–1.70)
Feet only	22	1.76 (0.62–4.97)	25	3.12 (1.10–8.89)	20	0.96 (0.44–2.11)	30	1.13 (0.68–1.88)
Foot and other pain	57	3.71 (1.88–7.32)	75	2.66 (1.13–9.25)	43	2.20 (1.27–3.82)	106	1.26 (0.92–1.71)

[a]Analyses included only people without any disability at baseline (no mobility difficulty (n = 426) and no IADL difficulty (n = 391)).

[b]Risk ratios (RRs) and 95% confidence intervals (CIs) generated from multivariable Poisson regression with robust variance estimators predicting onset of disability or physical performance decline adjusted for age, sex, race, education, body mass index, cognitive function (Mini-Mental State Examination), comorbid conditions (neuropathy, heart disease, diabetes mellitus, rheumatoid arthritis, asthma or lung disease, stroke, depression), level of physical activity (Physical Activity Scale for the Elderly score), daily analgesic use, and number of psychotherapeutic medications.

[c]Analyses included 608 (persons with SPPB score of ≤3 were excluded).

[d]Baseline physical performance was also adjusted for in the SPPB analyses.

resulting in a reliance on other weaker muscles of the back and lower extremities to maintain stability during walking and other movements. Inappropriate adaptive strategies may cause injury of muscles and joints, creating a progressively debilitating cycle.[35] Older persons with pain in multiple sites may be particularly vulnerable to neuromuscular changes over time, with greater functional consequences. Another explanation could be that central mechanisms cause the greater risk of disability whereby cognitive effects of chronic pain interfere with mobility. The experience of pain is associated with attentional and executive function deficits,[38] which are in turn associated with lack of mobility, falls, and functional dependence.[39,40]

The measures of IADL and pain interference are arguably overlapping constructs, although when all participants who had difficulty in IADLs at baseline were excluded, the results showed that any interference of pain, regardless of the level of interference, was a strong predictor of new IADL difficulty at follow-up. Pain interference may encompass "preclinical disability," indicating modification of the performance of a task in the absence of perceived difficulty.[41,42] In the Women's Health and Aging Study, task modification with mobility tasks was predictive of later declines in mobility function and was identified as a potential target for intervention.[41] Pain interference in the current study results may be akin to task modification and may be a potential clinical indicator of disability risk in older adults.

Objective assessment of physical function of older individuals (e.g., by use of the SPPB) is not a common component of standard clinical practice, but these results indicate that SPPB scores are sensitive to chronic widespread pain classified according to a modification of the ACR criteria and pain interference. Previous reports have shown that this measure of lower body mobility performance is predictive of functional disability, hospitalization, and mortality.[28,42,43] Standard clinical assessment using the SPPB to monitor mobility over time may shed light on underlying mechanisms leading to disability, including chronic pain.

Of the sites of pain studied, isolated back, hip, and knee pain were associated with deteriorating mobility, particularly mobility performance. In the specific pain-site analyses, only a few participants with musculoskeletal pain

reported having single-site pain only. The results revealed that multisite pain, regardless of specific sites involved, was highly prevalent and consistently associated with decline in function across domains. Approximately half of the incident disability was related to chronic pain based on the estimates of PAR. The persistence of multisite pain over time was also related to greater risk of disability. Thus, the evidence presented makes a strong case for assessing the global aspect of pain distribution and its persistence over time for the purpose of assessing disability risk in older adults. Widespread pain is not equated with fibromyalgia in the geriatric population, as it sometimes is in younger adults, and it was previously shown that prevalence of fibromyalgia based on widespread pain and tender point counts is low in older persons.[44]

The associations observed between chronic pain and subsequent onset of disability were independent of analgesic use, although even daily use of an analgesic is not synonymous with adequate pain management. A recent report from the MOBILIZE Boston Study showed that few participants had pain management consistent with current pain management guidelines.[45] Similarly, others have found that chronic pain is undertreated in older adults.[46] The current results point to the need for intervention research to examine approaches to pain management that will reduce risk of functional decline in older adults who live with chronic musculoskeletal pain. New approaches are needed because medications commonly used to treat pain often have side effects that create other risks or can increase disability risk (e.g., some analgesics might cause dizziness, fatigue, or altered mental status, leading to lack of mobility or falls).[47,48] Current guidelines for pain management in older adults call for combined use of pharmacological and nonpharmacological approaches.[49] Evidence supports use of nonpharmacological pain management such as cognitive–behavioral approaches, self-management of pain by providing education and teaching coping skills, exercise, and physical therapy,[50,51] but the overall effectiveness of these approaches in controlling pain and preventing disability is unknown.

Having a representative cohort of older community-dwelling people who were recruited door to door strengthens the generalizability of the current findings. Extensive measures of the characteristics of chronic pain were included, confirming the consistency of the effect of these global pain domains. This study also has some weaknesses that should be addressed. Although a number of chronic conditions were adjusted for, it is not certain that pathology rather than pain was the cause of the effects observed. There may have been other unmeasured factors associated with pain that could contribute to disability in this cohort of older adults. Finally, a follow-up period of 18-months was used, which might be considered short, but substantial functional decline was observed in 18 months in this aged population.

In sum, chronic musculoskeletal pain measured according to distribution, severity, and interference is strongly associated with risk of developing mobility and IADL difficulty and of clinically meaningful decline in mobility performance in older adults. In view of the progressively disabling effect of multisite musculoskeletal pain, future studies are urgently needed to determine whether pain management strategies targeting this chronic pain condition can prevent or control disability in older adults.

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APPENDIX 1: MOBILIZE BOSTON PAIN QUESTIONNAIRE, BASED ON THE WHAS BASELINE PAIN ASSESSMENT[1]

Now I would like to ask you questions about pain in different places in your body. Some of the questions have to do with pain in the past year and others have to do with pain in the past month.

1 During the past year, have you had pain, aching or discomfort in your BACK on most days for at least three months?

0. No [SKIP next Q.] 1. Yes

2 Please rate the average pain, aching or discomfort in your back during the past month, from 0 to 10 as shown on the card, where 0 is no pain and 10 is severe or excruciating pain, as bad as you can imagine? ___ Level of pain (0–10)

[1]Hochberg MC, Corti MC, Ferrucci L, Guralnik JM: Musculoskeletal Disease. In: *The Women's Health and Aging Study: Health and Social Characteristics of Older Women with Disability*. Edited by Guralnik JM, Fried LP, Simonsick EM, Kasper JD, Lafferty ME. Bethesda, MD: National Institutes on Aging; 1995.

3 During the past year, have you had pain, aching or discomfort in your SHOULDERS on most days for at least three months?

0. No [SKIP next Q.] 1. Yes

4 Please rate the average pain, aching or discomfort in your shoulders during the past month, from 0 to 10, where 0 is no pain and 10 is severe or excruciating pain, as bad as you can imagine? ___ Level of pain (0–10) or code 88 Refused; 99 Don't know/Non-valid response

5 During the past year, have you had pain, aching or discomfort in your HANDS OR WRISTS on most days for at least three months?

0. No [SKIP next Q.] 1. Yes

6 Please rate the average pain, aching or discomfort in your hands or wrists during the past month, from 0 to 10, where 0 is no pain and 10 is severe or excruciating pain, as bad as you can imagine? ___ Level of pain (0–10) or 88 Refused; 99 Don't know/Non-valid response

7 During the past year, have you had pain, aching or discomfort in your HIPS on most days for at least three months?

0. No [SKIP next Q.] 1. Yes

8 Please rate the average pain, aching or discomfort in your hips during the past month, from 0 to 10, where 0 is no pain and 10 is severe or excruciating pain, as bad as you can imagine? ___ Level of pain (0–10) or 88 Refused; 99 Don't know/Non-valid response

9 During the past year, have you had pain, aching or discomfort in your KNEES on most days for at least three months?

0. No [SKIP next Q.] 1. Yes

10 Please rate the average pain, aching or discomfort in your knees during the past month, from 0 to 10, where 0 is no pain and 10 is severe or excruciating pain, as bad as you can imagine? [Show card #9] ___ Level of pain (1–10) or 88 Refused; 99 Don't know/Non-valid response

11 During the past year, have you had pain, aching or discomfort in your FEET on most days for at least three months?

0. No [SKIP next Q.] 1. Yes

12 Please rate the average pain, aching or discomfort in your feet during the past month, from 0 to 10, where 0 is no pain and 10 is severe or excruciating pain, as bad as you can imagine? ___ Level of pain (0–10) or 88 Refused; 99 Don't know/Non-valid response

13 During the past year, have you had pain, aching or discomfort in your chest?

0. No [SKIP next Q.] 1. Yes

14 Please rate the average pain or aching in your chest during the past month, from 0 to 10 as shown on the card, where 0 is no pain and 10 is severe or excruciating pain, as bad as you can imagine? ___ Level of pain (0–10) or 88 Refused; 99 Don't know/Non-valid response