Higher Perceived Stress Scale Scores Are Associated with Higher Pain Intensity and Pain Interference Levels in Older Adults

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OBJECTIVES: To determine the prevalence of bodily pain measures (pain intensity and interference) in elderly people and their relationship with Perceived Stress Scale (PSS) scores.

DESIGN: Cross-sectional.

SETTING: Community.

PARTICIPANTS: A representative community sample of 578 individuals aged 70 and older (mean age 78.8, 63% female).

MEASUREMENTS: The prevalence of pain intensity and pain interference and their relationship with PSS scores, demographic factors, past medical history, and neuropsychological testing scores were examined. Pain intensity and pain interference were measured using the Medical Outcomes Study 36-item Short-Form Survey bodily pain questions.

RESULTS: Bivariate analysis for pain measures showed that PSS scores, neuropsychological test scores, and medical histories were associated with pain intensity and interference. Logistic regression showed that higher PSS scores were significantly associated with greater odds of having moderate to severe pain intensity and moderate to severe pain interference (with and without the inclusion of pain intensity in the models).

CONCLUSION: Higher PSS scores are associated with greater pain intensity and interference. In this cross-sectional analysis, directionality cannot be determined. Because perceived stress and pain are potentially modifiable risk factors for cognitive decline and other poor health outcomes, future research should address temporality and the benefits of treatment. **J Am Geriatr Soc 62:2350–2356, 2014.**

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Key words: chronic pain; pain intensity; pain interference; elderly

The Institute of Medicine classifies chronic pain as a public health problem that affects 100 million adults and has an annual economic cost ranging from $560 to $635 billion.[1] Where applicable, research should identify potentially modifiable risk factors, and stakeholders should enact approaches aimed at pain prevention, treatment, and care.[1]

Cognitive, psychological, and behavioral factors influence the pain experience.[2–4] Chronic pain is associated with psychopathology, including psychiatric and psychological disorders.[2] Psychological factors are important in coping, quality of life, and disability that individuals with chronic pain experience.[4] Research has identified an association between perceived stress and various pain syndromes, including recurrent, orofacial, and arthritis-related pain.[5–7] The Perceived Stress Scale (PSS) is a psychosocial measurement of an individual's appraisal of life events as stressful.[8–10] It focuses on the subjective experience and how life is unpredictable, uncontrollable, and overloading. The PSS is correlated with objective stress scales but is considered a more-accurate reflection of stress experienced. Objective stress scales count number of stressful events, ignoring personal and contextual factors. In comparison, the PSS measures a cognitively mediated emotional response to an objective event, incorporating an individual's social support system, robustness, and locus of control.[8–10]

The relationship between perceived stress and bodily pain has not been studied, particularly in an elderly community-based population. There is a paucity of epidemiological research on temporally concurrent perceived stress and its association with pain measures. Concurrent analysis is important, because perceived stress is variable over time and changes in response to an individual's current daily hassles, major life events, and present coping ability.[9]

The current study examined the association between perceived stress and bodily pain measures in elderly adults

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over a 4-week period using cohort data from the Einstein Aging Study (EAS). Pain outcomes included intensity (severity) and interference (pain-related disability). It was hypothesized that higher levels of perceived stress would be associated with higher levels of both measures.

METHODS

Study Population

Participants in this study were sampled from the EAS, a methodically recruited, population-based longitudinal study of adults aged 70 and older who reside in Bronx County, New York. Study design, enrollment procedures, and methods have been previously described.[11] It has been demonstrated that the EAS is representative of the English-speaking elderly community living in the Bronx in terms of age, sex, and education.[11] Participants were recruited using voter registration lists and Medicare eligibility information. Exclusion criteria included non-English speaking, severe audiovisual disturbances, prevalent dementia, institutionalization, or any condition that would interfere with participation (active psychiatric symptoms). Written informed consent was obtained during clinic visits in accordance with study protocols that the institutional review board of the Albert Einstein College of Medicine approved.

Clinical Evaluation

Participants were evaluated using demographic surveys, a structured medical history form, and queries concerning personal events. The entirety of the study sample was dementia free as ascertained at case conferences with neuropsychology and neurology input using standardized clinical criteria from the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Revision.*[12]

Medical conditions with the highest prevalence in the study population were focused on diabetes mellitus, congestive heart failure, hypertension, angina pectoris, myocardial infarction, stroke, chronic obstructive lung disease, and osteoarthritis. Lifestyle variables, alcohol consumption, and smoking history were included because of their effect on pain. Alcohol consumption over the past year (in grams) was categorized into tertiles, the lowest tertile serving as reference. Smoking history was categorized as never, former, and current smoker.

Neuropsychological Evaluation

Prior literature has shown an inverse relationship between neuropsychological function and pain measures, necessitating inclusion of neuropsychological factors in the models to control for possible confounding. The reading subtest grade equivalency score from the Wide Range Achievement Test (WRAT3)[13] has a continuous range from 1 to 13. The Wechsler Adult Intelligence Scale, Third Edition,[14] Verbal IQ (VIQ) score reflects performance on language-based tests of comprehension and problem-solving. Free recall (range 0–48) is a measure of episodic memory from the Free and Cued Selective Reminding Test.[15] Phonemic fluency[16] (FAS Verbal Fluency Test; number of correctly named words starting with letters F, A, or S.) and a test of set shifting and concept formation (Trail-Making Test Part B;[17] seconds to test completion) were used to measure executive functioning. Depressive symptoms were evaluated using the 15-item Geriatric Depression Scale (GDS); a score of 5 or more was defined as positive.[18]

Stress Evaluation

The PSS is a global assessment of an individual's perception of psychological stress during the past month;[9] the original scale consisted of 14 items. The PSS was included in the EAS testing battery in 2006. Prior factor analysis performed in this cohort identified a two-factor solution,[19] consistent with published literature; item 12 did not load strongly on either factor and was not included in the analysis. The current study modified-measure PSS-13 had reliable factor structure and predictive validity in the population sample.[19] The scale contained six negatively worded items (1, 2, 3, 8, 11, 14) and seven positively worded items (4, 5, 6, 7, 9, 10, 12). Each item was rated on a 5-point scale. Scores were calculated after reverse-keying positive items and summation of scores. Possible total scores range from 0 to 52 (higher score indicating greater stress, although this effect is nonlinear). The PSS is not a diagnostic instrument, and no predetermined cutpoints delineate different levels of perceived stress. For the current analysis, PSS was modeled two ways: divided into equally weighted quartiles with the first quartile (lowest levels of stress) serving as the reference group and as a continuous variable.

Pain Evaluation

Bodily pain measures were drawn from the Medical Outcomes Study 36-item Short-Form Survey.[20] Pain intensity was evaluated as the response to the question, "How much bodily pain have you had during the past 4 weeks?" Responses range from 1 (none) to 6 (very severe). Participants were dichotomized into two groups: no or mild pain intensity versus moderate to severe pain intensity. Pain interference was evaluated as the response to the question, "During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?" Responses range from 1 (not at all) to 5 (extremely). Participants were dichotomized into two groups: no or mild pain interference versus moderate to severe pain interference. These methods of surveying and categorizing bodily pain outcomes have previously been used in population-based studies.[21,22]

Statistical Analysis

Analyses were performed using Stata software version 12.1 (StataCorp, College Station, TX). Characteristics were compared separately for the dichotomous outcome variables pain intensity and pain interference and the independent variables describing participants' demographic and medical history. Continuous variables were compared using two-sample *t*-tests or, when the variables had a distribution far from normal, Mann–Whitney Wilcoxon tests. Categorical variables were compared using the Pearson chi-square test or Fisher exact test.

Logistic regression models were fit to the data to examine the effect of PSS on pain status. Separate models were developed for pain intensity and pain interference (no or mild vs moderate to severe) with and without inclusion of pain intensity in the models. In an effort to take into account potential confounders, variables with bivariate baseline testing results of $P \leq .25$ or variables, such as age, race, and sex, that were selected a priori were included in the models. This was repeated with PSS as a categorized and continuous variable. Statistical significance was assigned at an alpha level of .05. High odds ratios indicate the greater likelihood of pain intensity or interference. The odds ratios for continuous variables such as age represent the change in odds for each additional unit change. Model assumptions of normality and linearity were assessed graphically and statistically; goodness-of-fit testing was performed.

RESULTS

Between February 2006 and February 2012, 806 individuals were evaluated for inclusion in the EAS, with 19 individuals excluded for prevalent dementia at baseline. Of the 787 dementia-free individuals considered for the current analysis, 578 had available pain and stress data from the same 4-week period and were included in the present analysis; 403 of these had complete covariate data, allowing for inclusion in logistic regression models.

Results of bivariate analysis show that moderate to severe pain intensity (Table 1) and interference (Table 2) were associated with higher levels of perceived stress. Logistic regression showed that higher levels of perceived stress were associated with greater odds of having moderate to severe pain intensity (OR = 1.05 per unit increase in PSS score, Table 3) and interference (OR = 1.07 per unit

Table 1. Demographic and Medical Characteristics of Subjects According to Pain Intensity

Characteristic	Total, N = 578	No or Mild Pain Intensity, n = 384, 66.4%	Moderate to Severe Pain Intensity, n = 194, 33.6%	*P*-Value
Demographic				
Age, mean ± SD	78.8 ± 5.4	78.9 ± 5.6	78.5 ± 5.1	.44
Female, n (%)	367 (63.5)	217 (56.5)	150 (77.3)	<.001
Race, n (%)				
African American	168 (29.1)	102 (26.6)	66 (34.0)	.11
Other	48 (8.3)	30 (7.8)	18 (9.3)	
Lifestyle, N (%)				
Smoking				
Nonsmoker	244 (44.4)	162 (44.0)	82 (45.3)	.76
Former	279 (50.8)	190 (51.6)	89 (49.2)	
Current	26 (4.7)	16 (4.4)	10 (5.5)	
Alcohol tertile				
1	158 (28.7)	96 (26.0)	62 (34.3)	.008
2	181 (32.9)	115 (31.2)	66 (36.5)	
3	211 (38.4)	158 (42.8)	53 (29.3)	
Perceived stress				
PSS score, mean (± SD)	16.4 (7.7)	15.6 (7.8)	17.9 (7.2)	<.001
PSS score (quartile), n (%)				
0–11 (1)	163 (28.2)	124 (32.3)	39 (20.1)	.003
12–16 (2)	145 (25.1)	97 (25.3)	48 (24.7)	
17–22 (3)	153 (26.5)	64 (16.7)	53 (27.3)	
23–50 (4)	117 (20.2)	64 (16.7)	53 (27.3)	
Psychological testing				
Depressive symptoms	64 (11.1)	33 (8.6)	31 (16.0)	.008
Wide Range Achievement Test 3 score, mean ± SD	12.0 ± 2.1	12.1 ± 2.0	11.9 ± 2.2	.34
Free and Cued Selective Reminding Test score, mean ± SD	30.5 ± 6.7	30.5 ± 6.9	30.6 ± 6.2	.87
Wechsler Adult Intelligence Scale, Third Edition, verbal intelligence quotient score, mean ± SD	109.2 ± 16.4	110.6 ± 16.5	106.4 ± 15.8	.01
FAS Verbal Fluency score, mean ± SD	35.6 ± 12.9	35.9 ± 13.0	34.9 ± 12.6	.38
Trail-Making Test Part B, seconds, mean ± SD	142.3 ± 73.1	141.4 ± 73.7	144.1 ± 72.2	.67
History of medical illnesses, n (%)				
Hypertension	374 (64.7)	238 (62.0)	136 (70.1)	.05
Myocardial infarction	39 (6.8)	23 (6.0)	16 (8.3)	.31
Stroke	44 (7.6)	28 (7.3)	16 (8.3)	.68
Diabetes mellitus	115 (19.9)	68 (17.7)	47 (24.2)	.06
Angina pectoris	32 (5.5)	18 (4.6)	14 (7.2)	.21
Osteoarthritis	377 (65.2)	220 (57.3)	157 (80.9)	<.001
Chronic obstructive pulmonary disease	44 (7.6)	19 (5.0)	25 (12.9)	.001
Congestive heart failure	22 (3.8)	11 (2.9)	11 (5.7)	.10

Continuous variables analyzed using analysis of variance; categorical variables analyzed using Pearson chi-square test or Fisher exact test. *P*-values refer to comparisons between pain intensity levels. Depressive symptoms were evaluated using the 15-item Geriatric Depression Scale.
SD = standard deviation; PSS = Perceived Stress Scale.

Table 2. Demographic and Medical Characteristics of Subjects According to Pain Interference

Characteristic	Total, N = 578	No or Mild Pain Interference, n = 481, 83.2%	Moderate to Severe Pain Interference, n = 97, 16.8%	*P*-Value
Demographic				
Age, mean ± SD	78.8 ± 5.4	78.9 ± 5.5	78.4 ± 5.4	.48
Female, n (%)	367 (63.5)	301 (62.6)	66 (68.0)	.31
Race, n (%)				
African American	168 (29.1)	137 (28.5)	31 (32.0)	.17
Other	48 (8.3)	36 (7.5)	12 (12.4)	
Lifestyle, N (%)				
Smoking				
Nonsmoker	244 (44.4)	205 (44.9)	39 (42.4)	.87
Former	279 (50.8)	230 (50.3)	49 (53.3)	
Current	26 (4.7)	22 (4.8)	4 (4.4)	
Alcohol tertile				
1	158 (28.7)	125 (27.2)	33 (36.3)	.03
2	181 (32.9)	147 (32.0)	34 (37.4)	
3	211 (38.4)	187 (40.7)	24 (26.4)	
Perceived stress				
PSS score, mean (± SD)	16.4 (7.7)	15.7 (7.6)	19.4 (7.3)	<.001
PSS score (quartile), n (%)				
0–11 (1)	163 (28.2)	152 (31.6)	11 (11.3)	<.001
12–16 (2)	145 (25.1)	120 (25.0)	25 (25.8)	
17–22 (3)	153 (26.5)	125 (26.0)	28 (28.9)	
23–50 (4)	117 (20.2)	84 (17.5)	33 (34.0)	
Psychological testing				
Depressive symptoms	64 (11.1)	40 (8.3)	24 (24.7)	<.001
Wide Range Achievement Test 3 score, mean ± SD	12.0 ± 2.1	12.1 ± 2.0	11.6 ± 2.4	.027
Free and Cued Selective Reminding Test score, mean ± SD	30.5 ± 6.7	30.7 ± 6.7	29.5 ± 6.3	.11
Wechsler Adult Intelligence Scale, Third Edition, verbal intelligence quotient score, mean ± SD	109.2 ± 16.4	110.0 ± 16.3	105.5 ± 16.5	.032
FAS Verbal Fluency score, mean ± SD	35.6 ± 12.9	35.7 ± 12.5	34.8 ± 1.5	.57
Trail-Making Test Part B, seconds, mean ± SD	142.3 ± 73.1	138.8 ± 71.0	159.0 ± 81.3	.01
History of medical illnesses, n (%)				
Hypertension	374 (64.7)	307 (63.8)	67 (69.1)	.32
Myocardial infarction	39 (6.8)	29 (6.0)	10 (10.3)	.13
Stroke	44 (7.6)	34 (7.1)	10 (10.3)	.27
Diabetes mellitus	115 (19.9)	88 (18.3)	27 (27.8)	.032
Angina pectoris	32 (5.5)	25 (5.2)	7 (7.2)	.43
Osteoarthritis	377 (65.2)	297 (61.8)	80 (84.5)	<.001
Chronic obstructive pulmonary disease	44 (7.6)	27 (5.6)	17 (17.5)	<.001
Congestive heart failure	22 (3.8)	16 (3.3)	6 (6.2)	.18

Continuous variables analyzed using analysis of variance; categorical variables analyzed using Pearson chi-square test or Fisher exact test. *P*-values refer to comparisons between pain intensity levels. Depressive symptoms were evaluated using the 15-item Geriatric Depression Scale.
SD = standard deviation; PSS = Perceived Stress Scale.

increase in PSS score, Table S2). Individuals in the second (OR = 2.12), third (OR = 2.47), and fourth (OR = 3.47) quartiles of PSS scores had greater odds of moderate to severe pain intensity than those in the first quartile (lowest levels of stress) (Table 3 and greater odds of moderate to severe pain interference (second quartile, OR = 5.13; third quartile, OR = 5.87; fourth quartile, OR = 7.32) (showing results for models with pain intensity included as a predictor, Table S2; similar results obtained in models without pain intensity included as a predictor, Table S1).

Logistic regression analysis also revealed the following significant associations for the bodily pain measures. Having moderate to severe pain intensity was associated with greater odds of congestive heart failure, osteoarthritis, and younger age (Table 3). Having moderate to severe pain interference was associated with greater odds of moderate to severe pain intensity, being non-Caucasian and non-African American, having depressive symptoms, having osteoarthritis, younger age, lower free recall scores, and lower levels of consumption of alcohol (Tables S1 and S2).

DISCUSSION

Higher level of perceived stress was associated with higher levels of pain intensity and interference in an elderly population of individuals without dementia. This association remained significant when age, sex, race, medical history, depressive symptoms, and neuropsychological test performance were included as covariates in the models and when modeled as continuous or categorical variables, indicating

Table 3. Logistic Regression Models for Pain Intensity (No or Mild vs Moderate to Severe Pain Intensity)

Variable	PSS Categorized	PSS Continuous
	Odds Ratio (95% Confidence Interval) *P*-Value	
PSS score (quartile) (reference 0–11 (1)		
12–16 (2)	2.12 (1.06–4.21) .03	
17–22 (3)	2.47 (1.24–4.92) .01	
23–50 (4)	3.24 (1.61–6.52) .001	
PSS score continuous (per unit)		1.05 (1.02–1.08) .003
Age	0.96 (0.92–1.00) .04	0.96 (0.92–1.00) .047
Sex	1.42 (0.85–2.37) .18	1.37 (0.82–2.27) .23
Race (reference Caucasian)		
African American	1.19 (0.67–2.12) .56	1.22 (0.69–2.16) .50
Other	0.82 (0.29–2.28) .71	0.83 (0.30–2.28) .72
Alcohol tertile (reference 1)		
2	0.92 (0.53–1.61) .78	0.96 (0.55–1.67) .89
3	0.55 (0.31–1.01) .05	0.57 (0.31–1.03) .06
Depressive symptoms	1.01 (0.83–1.23) .09	1.02 (0.84–1.25) .82
Wechsler Adult Intelligence Scale, Third Edition, verbal intelligence quotient score	1.00 (0.98–1.01) .70	1.00 (0.98–1.01) .64
Hypertension	1.28 (0.78–2.11) .33	1.26 (0.77–2.07) .37
Diabetes mellitus	1.10 (0.63–1.95) .73	1.12 (0.64–1.97) .70
Osteoarthritis	2.57 (1.53–4.30) <.001	2.61 (1.56–4.35) <.001
Angina pectoris	0.64 (0.23–1.82) .41	0.62 (0.22–1.74) .37
Chronic obstructive pulmonary disease	1.81 (0.78–4.21) .17	1.86 (0.81–4.27) .15
Congestive heart failure	3.87 (1.20–12.46) .02	4.22 (1.32–13.55) .01

Models include demographic factors and medical history variables with $P \leq .25$ in bivariate testing with pain intensity.
PSS = Perceived Stress Scale.

the robustness of our findings. This research focused on a community-based sample of older adults; prior research was focused on pediatric and middle-aged populations and examined specific pain syndromes.[5–7] This is the first study to the knowledge of the authors to examine the association between perceived stress and bodily pain measures.

The relationship between psychological distress and chronic pain[2–4] is often referred to as the diathesis-stress model of pain.[23,24] Chronic stress leads to dysregulation in the body's "supersystem" (comprising the nervous, endocrine, and immune systems), which regulates an individual's experience of pain.[23] The excess psychosocial distress increases the allostatic load placed on the body, resulting in chronic disorders, including pain.[23,24] Greater perceived stress has been associated with a broad array of adverse health outcomes.[25,26] Based on the results of the current study, the diathesis or vulnerability would be higher levels of perceived stress that the individual experiences, although the study did not examine other psychological constructs related to pain, limiting the ability to identify mediators or confounders in the perceived stress and pain pathways. A limitation of this study is that it was cross-sectional, so temporal sequences describing pain and stress cannot be established. Future research should explore longitudinal analysis to better explore these relationships.

The model results show that higher scores on the PSS were associated with greater pain intensity and interference (and remained significant when pain intensity level was included as a model predictor). Perceived stress may influence pain interference directly and through a pathway mediated by pain intensity.

It is most likely that a bidirectional relationship exists in which pain exacerbates stress, and stress exacerbates pain. Methods that reduce both may improve the adverse health outcomes linked to these common symptoms in late life. Research has linked the presence of high stress and chronic pain together as a risk factor for shortened telomere length and advanced cellular aging,[27] which is associated with negative health outcomes, including cardiovascular disease, cognitive function, and immune function. Presence of frequent musculoskeletal pain and perceived stress is a risk factor for poor work performance and ability,[28] so methods to reduce stress, including meditation, physical exercises, and coping strategies,[29,30] should be used and further explored.

This study has several limitations. Data were from a sample of individuals aged 70 and older who resided in Bronx, New York; questions about external validity exist and whether the results can be applied to other samples. Studies have shown that the prevalence of pain interference rises sharply with age;[22] the prevalence of chronic pain increases until approximately age 65, followed by a plateau, and a decrease in reported pain for aged 75 and older.[21] Prevalence of medical histories in the EAS was previously found to be similar to rates for persons aged 65 and older in the United States.[11]

The EAS does not have sufficient data on participant anxiety, pain self-efficacy, pain coping, or pain acceptance. Future research should reexamine the current findings in light of these other psychological constructs. Some pain-associated disease states such as fibromyalgia were excluded from the analysis because of insufficient data. Self-reported data were relied on. Recall bias is a possibility, although this would tend to be nondifferential and would attenuate the results toward the null hypothesis. The bodily pain measures reflect a 4-week prevalence of pain and may not be representative of pain experienced for longer time periods. These pain measures were used in prior studies,[21,22] and it is believed they are representative of the pain experience. Lack of appropriate representation would most likely be nondifferential and would serve to attenuate the findings toward the null hypothesis.

In light of the economic recession (2008–09) and increase in perceived stress due to nationwide financial and occupational uncertainties, one potential limitation of this study was the use of PSS data ranging from 2006 to 2012. A previous study examined this question and reported that the associated increase in perceived stress did not affect individuals aged 65 and older,[8] who were representative of the current study population.

This study has a number of strengths. The sample was drawn from the EAS, a large ethnically diverse population-based study. The EAS uses well-established procedures to ascertain demographic information, medical history, and neuropsychological scores. The measures for pain[21,22] and perceived stress[4,9,10] have been previously studied and shown to be psychometrically accurate and reliable. These measures were temporally balanced during the same 4-week time period, allowing for concurrent associations between perceived stress and pain to be calculated. The models included all covariates with $P \leq .25$ in bivariate testing, and the authors believe that the findings for perceived stress are conservative estimates.

The present study has shown that persons with higher levels of perceived stress report greater pain intensity and interference. Caution must be used in interpreting the results because they show only associations and not causality. Future research should focus on interventional trials to determine whether stress-reducing techniques lead to a reduction in pain measures.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Table S1. Logistic regression models for pain interference (no interference/mild pain interference vs moderate/severe pain interference) without pain intensity level as a predictor.

Table S2. Logistic regression models for pain interference (no interference/mild pain interference vs moderate/severe pain interference) with pain intensity included as a predictor.

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