Dyspnea and Pain Frequently Co-occur among Medicare Managed Care Recipients

Nathan Clark[1], Vincent S. Fan[2,3], Christopher G. Slatore[4–6], Emily Locke[2], Heather E. Whitson[7,8], Linda Nici[9,10], and Stephen M. Thielke[11,12]

[1]University of Washington, [2]Health Services Research and Development, Department of Veterans Affairs (VA) Medical Center, and [3]Division of Pulmonary Medicine and Critical Care, University of Washington, Seattle, Washington; [4]Health Services Research and Development and [5]Section of Pulmonary and Critical Care Medicine, Portland VA Medical Center, and [6]Division of Pulmonary and Critical Care Medicine, Department of Medicine, Oregon Health and Science University, Portland, Oregon; [7]Department of Medicine (Geriatrics) and the Aging Center, Duke University Medical Center, and [8]Geriatric Research, Education, and Clinical Center, Durham VA Medical Center, Durham, North Carolina; [9]Pulmonary and Critical Care, Brown University, and [10]Providence VA Medical Center, Providence, Rhode Island; and [11]Psychiatry and Behavioral Sciences, University of Washington and [12]Geriatric Research, Education, and Clinical Center, Puget Sound VA Medical Center, Seattle, Washington

Abstract

Rationale: Experimental and neuroimaging studies have suggested strong associations between dyspnea and pain. The co-occurrence of these symptoms has not been examined in community samples.

Objectives: We sought to ascertain the co-occurrence of pain and dyspnea by self-report in a large cohort of Medicare recipients.

Methods: We analyzed data from 266,000 Medicare Managed Care recipients surveyed in 2010 and 2012. Dyspnea was defined by aggregating three questions about shortness of breath (at rest, while walking one block, and while climbing stairs). Pain was measured by four questions about pain interference, chest pain, back pain, and arthritis pain. All measures were dichotomized as high or low/none. We calculated the co-occurrence of pain and dyspnea at baseline, and generated logistic regression models to find the adjusted relative risk (RR) of their co-occurrence, adjusting for patient-level factors and three potential medical causes of dyspnea (chronic obstructive pulmonary disease/emphysema/asthma, congestive heart failure, and obesity). We modeled the simultaneous development and the simultaneous resolution of dyspnea and pain between baseline and 2 years.

Measurements and Main Results: Participants with dyspnea had considerably higher prevalence of pain than those without (64 vs. 18%). In fully adjusted models, participants with any of the types of pain were substantially more likely to report dyspnea than those without these types of pain (high pain interference: relative risk [RR], 1.99; 95% confidence interval [CI], 1.92–2.07; chest pain: RR, 2.11; 95% CI, 2.04–2.18; back pain: RR, 1.76; 95% CI, 1.71–1.82; and arthritis pain: RR, 1.49; 95% CI, 1.44–1.54). The relative risks of dyspnea developing or resolving at 2 years were greatly increased (RRs of 1.5 – 4) if pain also developed or resolved.

Conclusions: Pain and dyspnea commonly occurred, developed, and resolved together. Most older adults with dyspnea also reported pain. Medical conditions typically assumed to cause dyspnea did not account for this association. The most plausible explanation for the co-occurrence is physical deconditioning.

Keywords: dyspnea; pain; shortness of breath; Medicare

(Received in original form October 22, 2013; accepted in final form May 7, 2014)

Supported by NIMH K23 MH093591 (S.M.T.). C.G.S. is supported by a VA HSR&D Career Development Award and resources from the Portland VA Medical Center, Portland, Oregon. H.E.W. has been supported by the American Federation for Aging Research, the Duke Pepper Center (P30-AG-028716) and K23-AG-032867.

The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs or the United States Government.

Author Contributions: S.M.T. conducted the analyses, interpreted the results, and revised the drafts. N.C. developed the research strategy, helped interpret the results, and wrote the bulk of the first draft of the manuscript. V.S.F. assisted in planning the analyses and interpreting the results, and revised the manuscript. C.G.S. worked with S.M.T. to develop the analytic strategy, helped interpret results, and revised the manuscript. E.L. helped conduct the analyses and interpret the results. H.E.W. helped to interpret results and wrote and edited parts of the manuscript. L.N. assisted in interpreting the results and edited the manuscript.

Correspondence and requests for reprints should be addressed to Stephen Thielke, M.D., M.S.P.H., M.A., Geriatric Research, Education, and Clinical Center, Puget Sound VA Medical Center, GRECC S-182, 1660 South Columbian Way, Seattle, WA 98108. E-mail: sthielke@u.washington.edu

Ann Am Thorac Soc Vol 11, No 6, pp 890–897, Jul 2014
Published 2014 by the American Thoracic Society
DOI: 10.1513/AnnalsATS.201310-369OC
Internet address: www.atsjournals.org

A consensus statement from the American Thoracic Society (ATS) defined dyspnea as "a subjective experience of breathing discomfort that consists of qualitatively distinct sensations that vary in intensity" (1). Population studies have identified dyspnea in roughly one-quarter of patients in outpatient settings, and in one-quarter of adults aged 70 years and over (2, 3). Several models of dyspnea have been proposed to account for the experiences attending it, including air hunger, tightness, a sense of excessive work of breathing, other sensations, and affective responses (4). These models typically distinguish the sensory or perceptual experience of dyspnea, from the affective distress caused by it, from the impact which the symptom causes. Research has reaffirmed the conclusion of an earlier ATS consensus statement that the experience of dyspnea is influenced by physiological, psychological, social, and environmental factors (5).

A variety of lines of research have concluded that dyspnea and pain are strongly associated. More than 50 years ago it was suggested that pain could, as a multifactorial symptom, serve as a model to conceptualize dyspnea (6). Both are noxious internal experiences (7), and both may warn of a threat to the individual's well-being (1). The same language is often used to describe both (4, 8, 9), and they may overlap in the degree of unpleasantness and intensity (10). Both may be processed through similar neurophysiological pathways (11, 12). Some experimental studies among healthy control subjects, however, have found that whereas pain may augment dyspnea, dyspnea does not seem to augment pain (7, 13).

Despite these many points of overlap, published studies have not estimated the co-occurrence of dyspnea and pain in community samples. The co-occurrence between dyspnea and pain has particular relevance for older adults, because both of these symptoms, and the medical conditions associated with them, increase in prevalence during aging. We sought to quantify the association between dyspnea and four measures of pain in a large sample of community-dwelling older adults, with and without controlling for comorbidities that may cause dyspnea. The results have relevance for the epidemiology of both conditions, for the clinical care of patients with either or both of them, for theories of

Table 1. Categories used to dichotomize responses for the main outcome (dyspnea) and the predictors (four types of pain), with number and percentage providing each response at baseline

	Dyspnea* (*n*, %)	**No Dyspnea (*n*, %)**
During the past 4 weeks, how often have you felt short of breath while sitting or resting?	Most of the time (2,398, 0.9%) All of the time (3,881, 1.5%)	None of the time (20,1592, 78.9%) A little of the time (27,757, 10.9%) Some of the time (19,951, 7.8%)
During the past 4 weeks, how often have you felt short of breath while walking?	Most of the time (19,274, 7.6%) All of the time (20,689, 8.2%)	None of the time (144,589, 57.2%) A little of the time (37,136, 14.7%) Some of the time (30,982, 12.3%)
During the past 4 weeks, how often have you felt short of breath while climbing one flight of stairs?	All of the time (23,139, 11.6%)	None of the time (119,685, 47.8%) A little of the time (46,572, 18.6%) Some of the time (31,271, 12.5%) Most of the time (23,978, 9.6%)
	High Pain Interference (*n*, %)	**Not High Pain Interference (*n*, %)**
During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?	Quite a bit (49,954, 19.3%) Extremely (19,215, 7.4%)	Not at all (74,751, 28.9%) A little (66,368, 25.7%) Moderately (48,007, 18.6%)
	Chest Pain or Pressure (*n*, %)	**No Chest Pain or Pressure (*n*, %)**
During the past 4 weeks, how often have you had chest pain or pressure when resting	Most of the time (8,897, 3.5%) All of the time (5,633, 2.2%)	None of the time (180,813, 71.1%) A little of the time (32,994, 13.0%) Some of the time (26,113, 10.3%)
	Back Pain (*n*, %)	**No Back Pain (*n*, %)**
In the past 4 weeks, how often has low back pain interfered with your usual daily activities (work, school, or housework)?	Most of the time (27,406, 10.7%) All of the time (23,314, 9.1%)	None of the time (104,035, 40.7%) A little of the time (52,511, 20.6%) Some of the time (48,138, 18.8%)
	Arthritis Pain (*n*, %)	**No Arthritis Pain (*n*, %)**
During the past 4 weeks, how would you describe any arthritis pain you usually had?	Moderate (69,627, 27.5%) Severe (30,475, 12.0%)	None (60,395, 23.8%) Very mild (43,005, 17.0%) Mild (49,999, 19.7%)

*A positive response to any of the three questions about shortness of breath was considered to signify the presence of dyspnea.

aging and health, and for the development of novel interventions.

Methods

We analyzed data from cohort 12 of the Medicare Health Outcomes Survey, which assessed subjective health status among Medicare Managed Care recipients in 2010, with follow-up in 2012 (14). Survey respondents were selected from 382 Medicare Advantage organizations in the United States. Medicare Advantage organizations with 500 to 1,200 enrollees were required to have all of their enrollees participate. Surveys were mailed to a random sample of 1,200 enrollees for Medicare Advantage organizations with more than 1,200 members. For our analyses, we used the publically accessible data file, which included only de-identified and aggregated data. Because there was no patient-identifiable information, this was not considered human subjects research, and institutional review board approval was not sought.

Measures

Table 1 shows the measures used to assess dyspnea and pain. We grouped and categorized variables to estimate the co-occurrence of dyspnea and the four different types of pain. The dyspnea responses were aggregated and dichotomized to define presence or absence of significant dyspnea. If respondents answered "All of the time" or "Most of the time" to the questions about sitting or resting, or walking less than one block, or if they answered "All of the time" to the question about climbing stairs, they were categorized as having dyspnea. Those who made any other responses were considered not to have dyspnea. If fewer than two of these three questions were answered, the respondent's response was considered missing. Because there were different response options for the pain variables, we dichotomized these rather than analyzing them as continuous measures. For all four pain items, we defined a high degree of pain as a response of the highest or second-highest degree (interfering quite a bit or extremely; interfering all or most of the time; and moderate or severe pain).

We selected covariates that are recognized as causes of shortness of breath, or that might modify the relationship between dyspnea and pain, or that might globally influence report of symptoms. Congestive heart failure was defined by a single question, "Has a doctor ever told you that you have congestive health failure?" A similar yes/no question asked if respondents had "emphysema, or asthma, or COPD (chronic obstructive pulmonary disease)." Smoking was identified by a question about frequency; those who reported smoking every day or some days were considered smokers. Obesity was identified by self-reported weight and height, and those with a body mass index greater than 30 kg/m^2 were defined as obese; all others were considered nonobese. Depressive symptoms, which may influence symptom reporting (15), were identified with a single yes/no question, "In the past year, have you had 2 weeks or more during which you felt sad, blue or depressed; or when you lost interest or pleasure in things that you usually cared about or enjoyed?" Significant functional impairments, which may co-occur in individuals with poor health, were assessed using six questions about activities of daily living (ADLs): bathing, dressing, eating, getting in or out of chairs, walking, and using the toilet. Each question asked, "Because of a health or physical problem, do you have any difficulty doing the following activities without special equipment or help from another person?" The response categories were "No, I do not have difficulty," "Yes, I have difficulty," and "I am unable to do this activity." Those who made either of the latter two responses for any of the six activities were considered to have an ADL impairment.

Other covariates included age (dichotomized as less than 75 yr of age or 75 yr or older), sex, education (dichotomized as less than high school or high school or more), race (dichotomized as white or black/African American/other), and marital status (married or unmarried). Age and race could not be analyzed in any smaller categories because the response fields were aggregated into these groupings in the public use Medicare Health Outcomes Survey data set.

Analyses

Using baseline data, we produced descriptive results for those with and without dyspnea and with and without pain, and compared the groups using *t* tests or chi-square tests. We then constructed logistic regression models, with dyspnea as the dependent variable, and each type of pain as the independent variable. We used generalized linear regression with a log link, Poisson distribution, and robust variance estimator to calculate adjusted risk ratios (RRs). The RR coefficient represents the adjusted prevalence of dyspnea among those with the predictor (pain or another factor), divided by the prevalence of dyspnea among those without the predictor. The first model adjusted for sociodemographic variables, and the second adjusted for sociodemographic variables and health-related factors.

We examined the simultaneous development or resolution of dyspnea and each of the pain types between baseline and 2 years. The same questions were repeated at both time points, and we used the same definitions of pain and dyspnea in Table 1. Among those who had neither dyspnea nor one of the specific types of pain at baseline, we calculated the percentages developing dyspnea, pain, or both. Among those who had both dyspnea and pain at baseline, we calculated the percentages with resolving dyspnea, pain, or both. We calculated the adjusted RRs of dyspnea developing or resolving if each type of pain also developed or resolved. To ascertain if the co-occurrence was independent of differences in respondent characteristics, we controlled the same sociodemographic variables and health-related factors as described previously. For the sake of comparison, we also calculated the adjusted RRs for developing or resolving dyspnea in the setting of developing or resolving lung disease (emphysema, asthma, or COPD) or congestive health failure (CHF), adjusting for the same variables as described previously.

Respondents who did not answer more than one of the dyspnea questions at baseline were excluded. Each of the four pain analyses was considered separately, with no exclusion or modification based on failure to respond to other pain questions at baseline. For the analyses of development and resolution, we included only participants who had measurements at both baseline and 2-year follow-up. Because a large number of participants switched Medicare plans during the 2-year interval, and information about death was available only if the participant was still enrolled, we did not attempt to impute missing data.

Table 2. Baseline and follow-up characteristics of groups with and without dyspnea

	No Dyspnea (Baseline *n* = *201,959*, Follow-up *n* = *94,021*)	Dyspnea (Baseline *n* = *43,816*, Follow-up *n* = *19,411*)	Entire Group (Baseline *n* = *245,775*, Follow-up *n* = *113,432*)
Age 75 yr or over	38% (37%)	37% (37%)	38% (37%)
Female	56% (57%)	62% (63%)	57% (58%)
White	81% (83%)	72% (76%)	79% (82%)
Less than high school education	25% (22%)	40% (44%)	28% (25%)
Married	56% (58%)	42% (44%)	54% (55%)
Emphysema, asthma, or COPD	12% (12%)	42% (43%)	17% (17%)
Congestive heart failure	7% (6%)	25% (25%)	10% (10%)
Obese (BMI > 30)	25% (24%)	46% (45%)	28% (28%)
Current smoker	11% (10%)	19% (17%)	12% (11%)
Any impairment in activities of daily living	31% (28%)	83% (72%)	40% (36%)
Depressed in last year	21% (19%)	56% (47%)	28% (24%)
High pain interference	18% (18%)	64% (64%)	26% (25%)
Chest pain or pressure at rest	2% (2%)	23% (21%)	6% (5%)
Back pain	13% (12%)	50% (49%)	19% (19%)
Arthritis pain	33% (33%)	67% (68%)	39% (39%)

Definition of abbreviations: BMI = body mass index; COPD = chronic obstructive pulmonary disease.
All *P* values for the difference between groups were less than 0.001, except for age category, for which $P = 0.37$.

We analyzed the data with Stata IC, version 11.2 (StataCorp, College Station, TX).

Results

The overall potential sample size for cohort 12 of the Medicare Health Outcomes Survey was 487,861. Of these, 245,775 respondents answered all of the dyspnea questions and at least one pain question, an overall response rate of 50.3%. A total of 43,816 participants (18%) reported dyspnea as defined by the criteria in Table 1. Another 2,518 met all three of the dyspnea criteria (short of breath at rest, short of breath while walking, short of breath while climbing one flight of stairs), and 21,279 met two of the three criteria. A total of 1,729 met only the "at rest" criterion, 13,405 met only the "walking" criterion, and 4,885 met only the "stairs" criterion.

The baseline and follow-up characteristics for participants with and without dyspnea are shown in Table 2. There were substantial differences between groups based on dyspnea status at baseline, significant at $P < 0.001$ for all comparisons except the age category, which did not differ. Of the participants with dyspnea, 64% reported pain interfering with their normal work, and 18% of participants without dyspnea reported this. Of those with dyspnea, 23, 50, and 67% of participants experienced chest pain, back pain, and arthritis pain, respectively, as opposed to 2, 13, and 33% of participants without dyspnea. Of participants with dyspnea, 83% experienced at least one ADL impairment, compared with 31% without dyspnea. Of participants with dyspnea, 56% reported having been depressed in the last year, compared with 21% without dyspnea. There were 113,432 participants who completed the dyspnea questions at 2-year follow-up (a 74.4% response rate from baseline, after accounting for those who died). The characteristics of each of the groups at follow-up did not differ significantly from the characteristics at baseline.

Table 3 shows the adjusted relative risks for dyspnea given each of the types of pain. After we adjusted for sociodemographic factors, the RRs for the co-occurrence of dyspnea were 4.82 (95% confidence interval [CI], 4.73–4.91) for

Table 3. Adjusted relative risk ratios for co-occurrence at baseline of dyspnea with four types of pain and other covariates

	Relative Risk*† (95% CI)	Relative Risk†‡ (95% CI)
Pain		
High pain interference	4.82 (4.73–4.91)	1.99 (1.92–2.07)
Chest pain	4.75 (4.67–4.82)	2.11 (2.04–2.18)
Back pain	3.91 (3.84–3.98)	1.76 (1.71–1.82)
Arthritis pain	3.06 (3.00–3.12)	1.49 (1.44–1.54)
Other covariates		
Emphysema, asthma, or COPD	3.39 (3.33–3.45)	2.16 (2.10–2.23)
Congestive heart failure	2.99 (2.94–3.05)	1.59 (1.54–1.64)
Obesity	2.08 (2.02–2.14)	1.37 (1.34–1.41)
Smoking	1.50 (1.47–1.53)	1.09 (1.05–1.13)
Any ADL impairment	7.26 (7.08–7.45)	3.63 (3.46–3.81)
Depression within last year	3.13 (3.08–3.19)	1.52 (1.47–1.57)

Definition of abbreviations: ADL = activities of daily living; CI = confidence interval; COPD = chronic obstructive pulmonary disease.
*Each relative risk estimate is for a separate model adjusted for age, sex, race, education, and marital status. Nonpain variables were adjusted for all the types of pain simultaneously. The pain variables were not adjusted for the other pain variables.
†All relative risks significant at $P < 0.001$.
‡Adjusted for age, sex, race, education, and marital status, and all the other nonpain variables listed. Nonpain variables were adjusted for all the types of pain simultaneously. The pain variables were not adjusted for the other pain variables.

Table 4. Number and percentage of participants without dyspnea or each type of pain at baseline who had developed both at 2-year follow-up, and the relative risk of developing dyspnea given that pain developed

	Patients without Either Dyspnea or Each Pain/Health Condition at Baseline*	Patients [*n* (%)] Developing Both Dyspnea and Pain/Health Condition	Adjusted Relative Risk of Developing Dyspnea if Pain/Health Condition Also Developed (95% CI)†‡
High pain interference	77,990	2,131 (2.7%)	4.06 (3.81–4.32)
Chest pain	91,215	1,079 (1.2%)	4.58 (4.14–5.05)
Back pain	81,801	1,687 (2.1%)	3.26 (3.07–3.46)
Arthritis pain	62,943	1,608 (2.6%)	2.34 (2.19–2.51)
Emphysema, asthma, or COPD	81,993	941 (1.2%)	2.85 (2.65–3.07)
CHF	86,724	762 (0.9%)	2.60 (2.41–2.80)

Definition of abbreviations: CHF = congestive heart failure; CI = confidence interval; COPD = chronic obstructive pulmonary disease.
*Includes only participants who did not have either dyspnea or pain at baseline and who also answered questions about dyspnea and pain at 2-year follow-up. Each of the pain or health conditions was considered separately for defining group inclusion.
†Adjusted for age, sex, race, education, and marital status, obesity, smoking, any ADL impairment and depression; for pain variables, adjusted for emphysema and CHF; for emphysema and CHF, adjusted for all pain variables simultaneously.
‡All relative risks significant at $P < 0.001$.

high pain interference, 4.75 (95% CI, 4.67–4.82) for chest pain, 3.91 (95% CI, 3.84–3.98) for back pain, and 3.06 (95% CI, 3.00–3.12) for arthritis pain ($P < 0.001$ for all). After adjusting for the other factors that might cause dyspnea (emphysema, asthma, or COPD; congestive heart failure; obesity; and smoking) or that might influence symptom reporting or global health status (depression and ADL impairment), the RRs for dyspnea were 1.99 (95% CI, 1.92–2.07) for high pain interference, 2.11 (95% CI, 2.04–2.18) for chest pain, 1.76 (95% CI, 1.71–1.82) for back pain, and 1.49 (95% CI, 1.44–1.54) for arthritis pain ($P < 0.001$ for all).

Of those who did not have either dyspnea or each of the types of pain at baseline, 7% developed dyspnea at 2-year follow-up. Of this group, 11% developed high pain interference, 2% developed chest pain, 8% back pain, and 18% arthritis pain. As seen in Table 4, after adjusting for all the sociodemographic and health-related variables, the RRs for the simultaneous development of dyspnea with pain (compared with developing dyspnea without pain) were 4.06 (95% CI, 3.81–4.32) for high pain interference, 4.58 (95% CI, 4.14–5.05) for chest pain, 3.26 (95% CI, 3.07–3.46) for back pain, and 2.34 (95% CI, 2.19–2.51) for arthritis pain ($P < 0.001$ for all).

Among those who already had both dyspnea and one of the types of pain at baseline, the dyspnea resolved in 32% of cases. High pain interference resolved in 23% of cases, chest pain in 59%, back pain in 28%, and arthritis in 19% of cases. As seen in Table 5, after adjusting for all the sociodemographic and health-related variables, the RRs for the simultaneous resolution of dyspnea with pain (compared with dyspnea resolving without pain resolving) were 1.81 (1.70–1.92) for high pain interference, 4.14 (2.74–6.23) for chest pain, 1.91 (1.78–2.04) for back pain, and 1.54 (1.45–1.64) for arthritis pain ($P < 0.001$ for all). These risks were comparable

Table 5. Number and percentage of participants with both dyspnea and each type of pain at baseline who resolved one or both symptoms at 2-year follow-up, and the relative risk of resolving dyspnea given that pain resolved

	Patients with Both Dyspnea and Each Pain/Health Condition at Baseline*	Patients (%) with Both Dyspnea and Pain/Health Condition Resolving	Relative Risk of Dyspnea Resolving if Pain/Health Condition Also Resolved (95% CI)†‡
High pain interference	9,778	1,176 (12.0%)	1.81 (1.70–1.92)
Chest pain	3,774	878 (26.0%)	4.14 (2.74–6.23)
Back pain	7,814	1,102 (14.1%)	1.91 (1.78–2.04)
Arthritis pain	10,581	1041 (9.8%)	1.54 (1.45–1.64)
Emphysema, asthma, or COPD	6,576	471 (7.2%)	2.21 (2.02–2.41)
CHF	3,402	370 (10.9%)	1.68 (1.50–1.87)

Definition of abbreviations: CHF = congestive heart failure; CI = confidence interval; COPD = chronic obstructive pulmonary disease.
*Includes only participants who had dyspnea and pain at baseline and also answered questions about dyspnea and pain at 2-year follow-up. Each of the pain or health conditions was considered separately for defining group inclusion.
†Adjusted for age, sex, race, education, and marital status, obesity, smoking, any ADL impairment and depression; for pain variables, adjusted for emphysema and CHF; for emphysema and CHF, adjusted for all pain variables simultaneously.
‡All relative risks significant at $P < 0.001$.

to or greater than the relative risks of lung diseases (emphysema, asthma, or COPD) or CHF developing or resolving along with dyspnea.

Discussion

Using three questions about shortness of breath in a large sample of older American adults, we found that 18% of those surveyed endorsed dyspnea, which is consistent with other community samples. Much of the dyspnea was not associated with the clinical or pathophysiologic diagnoses commonly thought to underlie dyspnea or breathing discomfort (lung disease, congestive heart failure, obesity, and smoking). At baseline, participants with dyspnea had a considerably higher prevalence of high pain interference, chest pain, back pain, and arthritis pain than those without dyspnea. The adjusted relative risks for the co-occurrence of dyspnea and pain were, in models adjusted for sociodemographic and health-related characteristics, comparable to or even higher than the relative risks for the co-occurrence of dyspnea and the causes commonly assumed to underlie it.

Our findings are consistent with much of the research about similarities in the affective experiences of pain and dyspnea, as well as neuroimaging studies that show common neural mechanisms in both processes. Prior research has suggested that dyspnea and pain have many characteristics in common (10), but has not quantified how often, among large populations, pain is reported along with dyspnea. Our analysis found that individuals with dyspnea were considerably more likely than those without dyspnea to experience pain. For instance, 64% of those with dyspnea reported high pain interference, compared with 18% of those without dyspnea. Our analysis of changes during 2 years of follow-up (Tables 4 and 5) found that the two symptoms commonly developed or resolved together. Although this co-occurrence does not provide evidence for the same affective experiences or the same neurobiological mechanisms occurring in dyspnea and pain, it seems plausible that both may be facets of a common underlying experience, and that this may also involve depression and functional impairments (as seen in Table 2).

The causes, mechanisms, or circumstances that might result in a co-occurrence of pain and dyspnea are not readily discernable from these results. It is possible that the same individuals happened to experience both symptoms, even if dyspnea and pain were not related by a common pathway. For instance, individuals with dyspnea were far more likely to be obese, to have low education, and to smoke. Yet although there were some differences between the groups with and without dyspnea, controlling for patient-level factors did not greatly diminish the degree of co-occurrence of the symptoms. We also found no evidence that any of the medical factors commonly thought to underlie dyspnea (emphysema, asthma, or COPD; congestive heart failure; obesity; and smoking) accounted fully for its co-occurrence with pain, because in models adjusting for all of these factors (Table 3) the relative risks from pain were diminished by only about half, and remained in the range of 1.5–2 times relative risk. There may be other diseases or health states (as outlined in the ATS consensus statement [1]) that were not measured in this study that could account for both symptoms, but none of these are readily apparent.

Instead, it seems plausible that physical deconditioning, regardless of disease status, would cause individuals both to feel short of breath and to have various types of pain. The high prevalence (82%) of at least some degree of ADL impairment among those who reported dyspnea supports this explanation. The fact that arthritis pain (not directly related to the thoracic region) co-occurred commonly with dyspnea also suggests that low activity or physical limitations may be a common factor. This mechanism could explain how one symptom leads to the other, because if either dyspnea or pain by itself discouraged activity, over time the physical deconditioning could worsen and thus increase the likelihood of the other symptom. This line of reasoning could also account for the experimental studies that found that induced dyspnea does not augment nociception (7). The symptoms may not cause each other but rather be consequences of the same underlying process. Additional research using more detailed and multidimensional measures of dyspnea, pain, activity, and physical performance, over smaller intervals of time, could better ascertain the relationship between dyspnea and pain.

Appreciating the high likelihood that dyspnea and pain would co-occur may have clinical relevance in primary care and specialty care settings. First, in identifying dyspnea, pain, or both, providers can investigate and possibly address causes of physical deconditioning. Second, the two symptoms seem to have co-occurred whether or not dyspnea involved any of the medical causes we examined. This encourages providers to continue investigating the patient's experience of dyspnea even if they should fail to identify lung disease, heart disease, obesity, or other potential causes of dyspnea. This is a reminder of the physiological, psychological, social, and environmental factors that influence dyspnea (5), and the importance of considering them whether or not specific medical causes have been identified for it. Finally, recognizing that many patients will have both symptoms simultaneously, and that remission often occurs synchronously, could help clinicians to better understand the patient's symptoms and functioning and to select treatments that would be most likely to provide meaningful benefits for health and quality of life. Palliative care, for example, has long argued for more attention to both dyspnea and pain (16).

It is also possible that dyspnea and pain might be effectively treated simultaneously using the same modalities (17). Opioid analgesics have been long recognized as a way to reduce breathlessness (1), but it is possible that nonopioid analgesics could also help with subjective shortness of breath. Treatments targeted to reduce shortness of breath, such as oxygen, aerobic conditioning, or pulmonary rehabilitation, might reduce pain interference or even arthritis or back pain. To explore these possibilities, there may be merit in reanalyzing treatment trials for dyspnea and/or pain, to ascertain the effects on the other outcomes.

There are several limitations to this research. First, all the participants were enrolled in Medicare Managed Care, and thus may not be representative of older adults in America or other countries. Even though the entire sample was large, the sampling strategy and the low survey response rates may have under- or overrepresented certain groups. Second, our method of defining dyspnea relied on three questions and

dichotomized participants as having dyspnea or not. This approach has not been validated, and there may be different associations if dyspnea were measured using different questions, a continuous scale, or different response categories (18–22). The measure assessed the frequency of shortness of breath, but did not quantify the affective dimension of dyspnea, its degree, or its effects on activities. For this preliminary work, we chose to apply a definition that would have face validity and be easy to interpret. Third, our measure of assessing chest pain, a question about "chest pain or pressure," was nonspecific, and could be interpreted by some respondents to mean shortness of breath or labored breathing. Fourth, we used only self-report data, and self-perception of health status may confound the associations we sought to measure, for instance by encouraging people to answer in the affirmative to all questions about symptoms. Self-report of diseases in the Medicare Health Outcomes Survey has nevertheless been found to be reliable (23).

Fifth, as a result of coding of the database we were not able to examine age as a continuous predictor, or specific ethnicity/race categories. Sixth, in our longitudinal analyses, there was a 2-year window between our symptom assessments, and there may have been considerable variation during this time. If so, participants may have undergone episodes of relapse and remission that were not captured by this study design. More frequent independent variation in both symptoms would, however, mitigate rather than increase the strength of apparent associations during simultaneous incidence or resolution. Finally, in our analysis of developing and resolving pain and dyspnea (Tables 4 and 5), there was a significant amount of missing data; about one-quarter of the participants who filled out the survey in 2010 and who were still eligible 2 years later did not complete the survey in 2012. On the basis of the similarity in groups defined by dyspnea status between baseline and follow-up (seen in Table 2), we assumed that those individuals who dropped out did not differ substantially from those remained in the sample. Many of the losses to follow-up could be attributed to switching Medicare benefits plans, which was likely not a result of health status or symptoms. Because of data constraints, we did not examine death separately; about 10% of the sample died between baseline and follow-up. Additional research is needed to refine the temporal and causal associations between these symptoms, their associations with mortality, and the possibility of treating them both simultaneously.

Conclusions

Four types of pain co-occurred commonly with dyspnea, both cross-sectionally and during development or resolution over 2 years. Our findings suggest, in a large population, that individuals who report shortness of breath will be likely to report various types of pain. This adds to the body of research that has shown that dyspnea and pain share many features in common (10), and points to deconditioning as a plausible common mechanism underlying both. Recognizing and exploring the co-occurrence of dyspnea and pain in clinical settings could help health care providers to better understand patients' experiences, to select appropriate treatments, and possibly to treat both dyspnea and pain simultaneously. Additional epidemiologic, physiologic, and clinical research is needed to understand better how aversive symptoms such as pain and dyspnea are related and interact. ■

Author disclosures are available with the text of this occasional essay at www.atsjournals.org.

References

1 Parshall MB, Schwartzstein RM, Adams L, Banzett RB, Manning HL, Bourbeau J, Calverley PM, Gift AG, Harver A, Lareau SC, *et al.*; American Thoracic Society Committee on Dyspnea. An official American Thoracic Society statement: update on the mechanisms, assessment, and management of dyspnea. *Am J Respir Crit Care Med* 2012;185:435–452.

2 Kroenke K, Arrington ME, Mangelsdorff AD. The prevalence of symptoms in medical outpatients and the adequacy of therapy. *Arch Intern Med* 1990;150:1685–1689.

3 Ho SF, O'Mahony MS, Steward JA, Breay P, Buchalter M, Burr ML. Dyspnoea and quality of life in older people at home. *Age Ageing* 2001;30:155–159.

4 Lansing RW, Gracely RH, Banzett RB. The multiple dimensions of dyspnea: review and hypotheses. *Respir Physiol Neurobiol* 2009;167:53–60.

5 American Thoracic Society. Dyspnea: mechanisms, assessment, and management: a consensus statement. *Am J Respir Crit Care Med* 1999;159:321–340.

6 Comroe JH. Dyspnea. *Mod Concepts Cardiovasc Dis* 1956;25: 347–349.

7 Morélot-Panzini C, Demoule A, Straus C, Zelter M, Derenne JP, Willer JC, Similowski T. Dyspnea as a noxious sensation: inspiratory threshold loading may trigger diffuse noxious inhibitory controls in humans. *J Neurophysiol* 2007;97:1396–1404.

8 Gracely RH, Undem BJ, Banzett RB. Cough, pain and dyspnoea: similarities and differences. *Pulm Pharmacol Ther* 2007;20: 433–437.

9 De Peuter S, Van den Bergh O, Vlaeyen JW. Breathtaking! About the comparison of the subjective sensations of pain and dyspnea. *Pain* 2010;149:411–412, author reply 412–413.

10 von Leupoldt A, Dahme B. Experimental comparison of dyspnea and pain. *Behav Res Methods* 2007;39:137–143.

11 von Leupoldt A, Sommer T, Kegat S, Baumann HJ, Klose H, Dahme B, Büchel C. Dyspnea and pain share emotion-related brain network. *Neuroimage* 2009;48:200–206.

12 Nishino T. Dyspnea and its interaction with pain. *J Anesth* 2011;25: 157–161.

13 Nishino T, Shimoyama N, Ide T, Isono S. Experimental pain augments experimental dyspnea, but not vice versa in human volunteers. *Anesthesiology* 1999;91:1633–1638.

14 Jones N III, Jones SL, Miller NA. The Medicare Health Outcomes Survey program: overview, context, and near-term prospects. *Health Qual Life Outcomes* 2004;2:33.

15 Howren MB, Suls J. The symptom perception hypothesis revised: depression and anxiety play different roles in concurrent and retrospective physical symptom reporting. *J Pers Soc Psychol* 2011; 100:182–195.

16 Naqvi F, Cervo F, Fields S. Evidence-based review of interventions to improve palliation of pain, dyspnea, depression. *Geriatrics* 2009;64: 8–10, 12–14.

17 Banzett RB, Adams L, O'Donnell CR, Gilman SA, Lansing RW, Schwartzstein RM. Using laboratory models to test treatment: morphine reduces dyspnea and hypercapnic ventilatory response. *Am J Respir Crit Care Med* 2011;184: 920–927.

18 Lansing RW, Moosavi SH, Banzett RB. Measurement of dyspnea: word labeled visual analog scale vs. verbal ordinal scale. *Respir Physiol Neurobiol* 2003;134:77–83.
19 Camargo LA, Pereira CA. Dyspnea in COPD: beyond the modified Medical Research Council scale. *J Bras Pneumol* 2010;36: 571–578.
20 Kendrick KR. Can a self-rating 0–10 scale for dyspnea yield a common language that is understood by ED nurses, patients, and their families? *J Emerg Nurs* 2000;26:233–234.
21 Mador MJ, Rodis A, Magalang UJ. Reproducibility of Borg scale measurements of dyspnea during exercise in patients with COPD. *Chest* 1995;107:1590–1597.
22 Wiwanitkit V. Scale of dyspnea in COPD: user friendly? *Ann Thorac Med* 2010;5:55.
23 Miller DR, Rogers WH, Kazis LE, Spiro A III, Ren XS, Haffer SC. Patients' self-report of diseases in the Medicare Health Outcomes Survey based on comparisons with linked survey and medical data from the Veterans Health Administration. *J Ambul Care Manage* 2008;31:161–177.