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Dyspnea and Symptom Amplification in Asthma

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Key Words
Airway obstruction · Asthma · Dyspnea · Anxiety scale · Symptom amplification

Abstract
Background: The severity of a patient's asthma and the intensity with which he describes his dyspnea do not correlate. ***Objectives:*** There is an indirect relationship between airway function in asthma and the intensity of dyspnea; this relationship is found only when the measure of a patient's general tendency to exaggerate the intensity of any somatic symptom is considered simultaneously. ***Methods:*** Lung function, including spirometry (forced expiratory volume in 1 s, FEV_1) and plethysmography (airway resistance, R_{aw}), dyspnea (Borg scale score) and the tendency to exaggerate (the somatosensory amplification scale score, SSAS) have been quantified in 42 stable asthmatic patients. ***Results:*** There was no correlation between the Borg score and any spirometric or plethysmographic measure in these subjects. By contrast, there was a moderate correlation between the Borg score and the SSAS ($r = 0.36$, $p = 0.03$). However, when FEV_1 or R_{aw} (abscissa) and Borg scores (ordinate) were converted to residuals, there was a moderate correlation between the residuals and the SSAS score (for FEV_1, $r = 0.33$ and $p = 0.05$; for R_{aw}, $r = –0.36$ and $p = 0.03$). ***Conclusion:*** A physician may make a reasonable estimate of an asthmatic patient's lung function from the intensity of his complaint only if he – the physician – considers the patient's tendency to symptom amplify as well.
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When asthmatic patients experience dyspnea, the intensity of the symptom does not correlate well with the degree of their airway obstruction as determined by spirometry [1, 2]. While stable asthmatic patients always experience dyspnea after inhalation of a bronchoconstrictor agent, there is a wide range in the magnitude of dyspnea associated with any fixed decline (e.g., 20%) in their forced expiratory volume in 1 s (FEV_1) [3–5]. Some clinical investigators have pointed out that overdistension of the lung rather than increased airway resistance per se may account for dyspnea in asthma [6, 7]. However, to date, there have been no clinical surveys designed to identify relationships between simple measures of hyperinflation in asthma, such as inspiratory capacity or functional residual capacity, and dyspnea in non-exercising subjects.

Psychiatric disorders are common in asthmatic patients. Psychopathology in asthmatic people is associated with an increased utilization of health care [8, 9]. It follows that variability in the measures of the psychological state, psychological trait or other psychophysical factors may be associated with differences among asthmatics in either their ability to recognize changes in the magnitude of their inspiratory load or the intensity of dyspnea they experience during attacks. Anxious dependent asthmatic subjects, for example, are less able to recognize changes in inspiratory load than those with lower panic-fear behavioral styles [10]. In addition, those asthmatics scoring high on a scale measuring defensiveness are less accurate than others in their magnitude estimates of external, in-

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spiratory resistive loads. These subjects also perform poorly when asked to judge the quantity of respiratory sensations associated with loading. These data suggest that the link between load recognition and the magnitude of reported dyspnea is weak, at least in individuals with certain psychological traits [11]. A confirmatory study shows that the precision with which a young asthmatic identifies an external load and his sense of dyspnea do not correlate [12]. Finally, an alternate line of observation holds that suggestion may facilitate the provocation of bronchospasm [13, 14].

Scales are available in the psychiatry literature to quantify somatosensory amplification and/or hypochondriasis [15]. These phenomena refer to self-reported awareness or sensitivity to benign somatic and/or visceral sensations. Such amplification is independent of socioeconomic or educational status. While amplification may be associated with anxiety and depressive disorders, not all anxious or depressed persons are amplifiers. We hypothesize that asthmatic symptom amplifiers associate higher grades of dyspnea with bronchospasm than do non-symptom amplifying asthmatic patients; the correlation between airway function (but not lung volumes) and the magnitude of dyspnea can be found only when a measure of symptom amplification is considered as well.

Methods

Subjects

We studied 42 patients with mild to moderate asthma, all of whom had previously demonstrated wheezing and reversible airway obstruction by serial spirometry in our hospital-based pulmonary function laboratory. Patients were recruited from both the outpatient asthma clinic and the inpatient medical (asthma) service. All signed an informed consent document approved by the local institutional review board.

Procedures

To evaluate lung function, spirometry and plethysmography were performed with standard equipment (DS II Plus, WE Collins, Braintree, Mass., USA). Dyspnea was quantified by the modified Borg scale [16]. Patients were asked to rank the 'magnitude of your discomfort'. We purposely avoided the terms 'effort' and 'work'. However, we did not distinguish between the sensory and affective aspects of dyspnea [17, 18].

For psychometric evaluation, two tests were used. The Barsky somatosensory amplification scale (SSAS) consists of ten questions. Each question asks the subject to estimate the degree of discomfort associated with each of ten common but minor physical sensations [15]. Each sensation is thought not to reflect a major illness or pathology, e.g., the intensity of discomfort associated with hunger contractions. Second, we used the Hopkins symptom check list (HSCL-90). Sections of the revised HSCL-90 were used to examine three symptom dimensions: symptom amplification or somatization (HSCL-SOM), depression (HSCL-DEP) and anxiety (HSCL-ANX) [19].

Table 1. Estimates of pulmonary function and their correlation with estimates of dyspnea (Borg scale score)

Function	Value (mean ± SD)	Correlation coefficient (r)
FEV_1, % predicted	69 ± 26	0.17
R_{aw}, cm H_2O/l/s	3.2 ± 1.9	0.09
FRC, % predicted	136 ± 51	0.05
IC, % predicted	92 ± 21	0.10
SG_{aw}	0.13 ± 0.11	0.0

SG_{aw} = Specific airway conductance, or the reciprocal of airway resistance divided by FRC.

Protocol

Patients were seated comfortably for the collection of all data. Data, e.g., Borg scale scores, spirometry and responses to psychometric questionnaires, were collected in that order.

Data Analysis

Standard univariate and multiple regression analysis was used to explore the data.

To further examine the possible interrelationships between subjects' lung functions, their estimates of the degree of dyspnea and tendencies to amplify symptoms, we performed the following sequence of calculations. Individual least square regression was performed with each measure of lung function, i.e. inspiratory capacity (IC), functional residual capacity (FRC), FEV_1 and airway resistance (R_{aw}), plotted against the corresponding Borg scale score (dependent variable). For illustration, individual data points for FEV_1 (as percent of predicted) and corresponding Borg scale scores are shown in figure 1. The residuals for each of these four equations were then calculated for all data points. A positive residual, that is a residual in which the measured Borg scale score was greater than the Borg scale score predicted from the least squares prediction equation, would indicate a tendency for subjects to exaggerate their degree of dyspnea relative to the degree of lung or airway dysfunction. By contrast, a negative residual would suggest a tendency to minimize the intensity of a complaint. These residuals were then plotted against data obtained from administration of each of the psychometric tests, with those tests, e.g., the SSAS, taken as the dependent variable.

Results

Subjects were 40 ± 10 years of age (range 19–58). There were 33 females and 9 males. Pulmonary function data are shown in table 1. FEV_1 (as percent of predicted

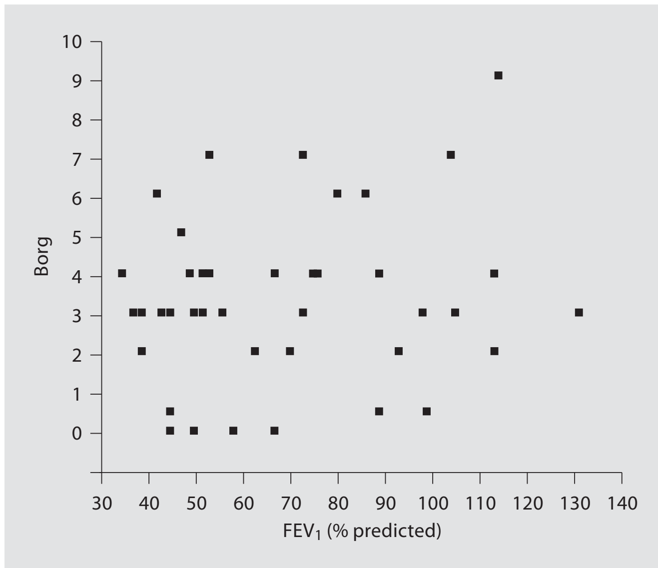

Fig. 1. Relationship between a measure of airway function (FEV_1) and dyspnea (Borg scale score) in all subjects. The equation (Borg = 2.3 + 0.01 FEV_1) is not statistically significant (r = 0.18, p = n.s.).

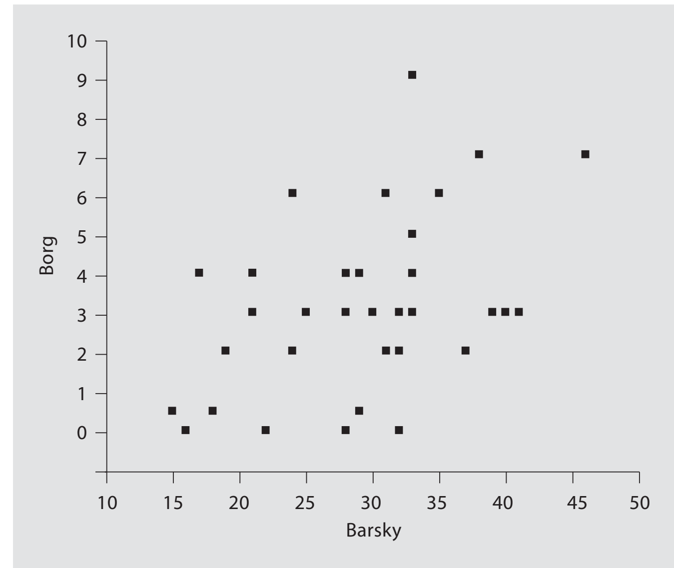

Fig. 2. Relationship between a measure of somatosensory amplification (SSAS or Barsky scale score) and dyspnea (Borg scale score) in all subjects. For all subjects: Borg = 0.3 + 0.1 SSAS (r = 0.36, p = 0.031).

value) was 69 ± 26 for all subjects. Thus, subjects showed various degrees of function ranging from mild to moderate impairment. Similarly, measures of R_{aw}, FRC and specific airway conductance were mildly to moderately abnormal while IC in most subjects was within the normal range. None of these variables correlated with the Borg score (fig. 1).

Subjects rated their dyspnea as 3.3 ± 2.1 Borg scale units. This suggests that on average, patients described their degree of dyspnea as being between 'moderate' and 'somewhat severe'. Quantitative assessment of the subject's performance on tests of the three measures of personality showed: SSAS 29 ± 7 units, with our measure of depression being 0.92 ± 0.8 units and our measure of anxiety 0.64 + 0.7 units. Barsky scores correlated well with the HSCL measure of somatosensory amplification (r = 0.39, p = 0.019).

The correlation between Borg scale scores and Barsky scores is shown in figure 2. A tendency for correlation also appeared between dyspnea (Borg) and anxiety: Borg = 0.7 + 0.2 HSCL-ANX (r = 0.30, p = 0.06).

By contrast, there was no correlation between HSCL-DEP and the Borg scale score (r = 0.17, p = n.s.), nor did any measure of airway function correlate with the measure of either anxiety or depression. Barsky scale scores and the HSCL-ANX scores were poorly correlated (r = 0.2). Finally, the Borg scale score and the HSCL-SOM scores did not correlate (r = 0.24, p = n.s.).

Relationships between Dyspnea, Lung Function and Measures of Personality

Multiple regression analysis using measures of lung function as independent variables showed no link between dyspnea, lung function and any measure of personality.

Correlation coefficients showing relationships between data obtained from the analysis of the residuals and data obtained from psychometric evaluation are given in table 2. Data from residuals calculated with both the FEV_1 and R_{aw} correlate with both the SSAS and the HSCL-ANX score (for FEV_1, p = 0.05 and p = 0.04, respectively; for R_{aw}, p = 0.03 and p = 0.05). By contrast, correlations between these same residuals and the HSCL-SOM score tended to, but did not, reach statistical significance ($0.05 < p < 0.1$).

Regarding static volumes, residuals generated from a plot of Borg scale scores versus FRC were related to the SSAS (p = 0.03). Otherwise, no other correlations between residuals involving any measure of static lung volume (IC or FRC) and any measure of psychometric evaluation were found.

Table 2. Correlation coefficients for psychological test scores (dependent variable) and residuals (independent variable); residuals are from the (previously calculated) least squares regression line between the Borg scale score and the corresponding measure of lung function

Variable	SSAS	HSCL-SOM	HSCL-ANX	HSCL-DEP
Borg/FEV_1				
r =	0.33	0.28	0.33	0.20
p =	0.05	n.s.	0.04	n.s.
Borg/R_{aw}				
r =	–0.36	–0.27	–0.32	–0.20
p =	0.03	n.s.	0.05	n.s.
Borg/FRC				
r =	0.35	0.24	0.29	0.16
p =	0.03	n.s.	n.s.	n.s.
Borg/IC				
r =	0.20	0.22	0.12	0.22
p =	n.s.	n.s.	n.s.	n.s.

n.s. = Not statistically significant.

Discussion

This study confirms the observations of others, namely that measures of dyspnea and measures of airway function correlate poorly in asthmatic subjects [1, 2, 20–22]. Our data extend previous observations in that we have first utilized a standard 10-unit numerical and categorical scale to measure dyspnea, and second, have included measures of behavioral characteristics of our subjects. Moreover, we have found an indirect link between some measures of lung function, e.g., FEV_1, R_{aw} and FRC, with dyspnea; however, this link can be observed only if a measure of each subject's tendency to symptom amplify is considered simultaneously. Therefore, a relationship that one might expect between lung function and dyspnea rating can be found but only if a given patient's tendency to amplify as reflected by the SSAS is taken into consideration.

Lung Function and Dyspnea

In this analysis, calculation of the residuals from the least squares regression analyses, relating measures of lung function (abscissa) to the corresponding Borg scale scores (ordinate), provided a unique index of somatization. In further analysis, plots of these residuals (abscissa) against data obtained with psychometric tools, e.g., the SSAS, allowed us to demonstrate an indirect relationship between estimates of lung function and estimates of the degree of dyspnea. This relationship we have shown depends upon the evaluation of patients' tendencies to exaggerate, e.g., their SSAS or HSCL-ANX scores. The fact that the residuals correlate with the SSAS scale supports the notion that the tendency to symptom amplify rather than the degree of airway obstruction per se is a determinant of asthmatic patients' ratings of the magnitude of dyspnea. This relationship was found if either a measure of large airway function (plethysmography) or a measure of global airway function (FEV_1) was used. That FEV_1 and R_{aw} could be used interchangeably was surprising. While a correlation between FEV_1 and the signs (or symptoms) of asthma is found over the range of airway function observed in this study group, the elevated R_{aw} as measured by plethysmography is often not seen in asthma unless patients show signs of severe airway obstruction, a degree of obstruction not seen in most of our patients [23].

Regarding static lung volumes, FRC and dyspnea were correlated when a measure of symptom amplification was taken into account. An explanation for this observation is not readily apparent. One possible explanation would hold that FRC, to some degree, may be influenced by personal or voluntary behavior and may not represent a resting position in the asthmatic subject. It is well recognized that some asthmatics reach a rest position at the end of each breath while others tonically contract respiratory muscles, either expiratory or inspiratory, at end exhalation [24]. Patients with high SSAS scores may contract expiratory muscles tonically and thereby increase their Borg scale score relative to the measured FRC.

Finally, while studies of asthmatics during exercise have suggested that the progressive decline in IC is the limiting factor in exercise tolerance, the IC measure had no bearing upon the link between lung volumes, dyspnea and personality characteristics in the evaluation of resting asthmatic subjects [7].

Dyspnea and Symptom Amplification

The self-report of dyspnea in asthmatic subjects correlates well with the variability of their likeliness to overestimate the severity or significance of any benign bodily sensation, e.g., exposure to cold, superficial pain. The notion that persons with somatoform disorders are likely to present with symptoms suggesting illness of visceral organs, e.g., esophagitis or coronary artery disease, where none exist (or exist in a very mild form) has been documented [25, 26]. This study extends this notion to dyspnea in asthmatic patients. The fact that the SSAS correlates with dyspnea more strongly than the HSCL-SOM

score is of interest. The SSAS is thought to assess awareness of multiple somatic symptoms while HSCL assesses the degree of physical discomfort associated with any given symptom.

These data hold important implications for the clinician. The intensity of asthmatics' complaints do not reflect the degree of their airway obstruction in those with 'mild' or 'moderate' dysfunction. In order for the physician to make a reasonable judgment of patients' airway functions from the degree to which they report dyspnea, the physician must have some sense as to whether or not the patients tend to overstate the degree of their symptoms in general. Of note, this notion that asthmatics with mild or moderate disease may err by overestimation of the severity of their illness does not apply to asthmatics with severe airway obstruction. In this latter group, underestimation of the disease severity may lead to inadequate treatment and, subsequently, greater morbidity and mortality [27, 28].

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