Measurement of dyspnoea in chronic obstructive pulmonary disease

E. G. Eakin, R. M. Kaplan* and A. L. Ries

San Diego State University Joint Doctoral Program in Clinical Psychology (E. G. Eakin), Department of Family and Preventive Medicine (R. M. Kaplan), Department of Medicine (A. L. Ries), University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0622, USA.

This paper reviews the assessment of shortness of breath in chronic obstructive pulmonary disease (COPD). The validity criteria for evaluating measures of dyspnoea are discussed and a description and critique of current measures of shortness of breath are offered. Across studies, dyspnoea measures are moderately correlated with pulmonary function (e.g. $FEV_{1.0}$ and FVC), psychological function, and walking tests (6 min walk). In addition, dyspnoea measures tend to be correlated with one another. The need for standardisation of dyspnoea measures for research and clinical practice is identified as an important objective for future work.

Key words: Chronic obstructive pulmonary disease, dyspnoea, pulmonary function.

Introduction

The chronic obstructive pulmonary diseases (COPD), which include emphysema, chronic bronchitis and non-reversible asthma, are major causes of death and disability in the United States. COPD ranks as the fifth leading cause of death and accounts for 4% of all deaths.[1-2]

Broadly defined, health-related quality of life refers to patient reported functional effects of an illness or a health care treatment. The rapidly growing field of clinical epidemiology is developing several different types of quality of life measures. All of these measures are similar in that they quantify patient reports of their illness experiences. Some quality of life measures are general and characterize the entire spectrum of functioning. Other methods in clinical epidemiology are used to quantify the effect of a specific symptom or problem upon life quality. In this paper we review measures with the greatest emphasis on techniques in the latter category. In particular, we focus on measures of a particular symptom—shortness of breath.[3]

General quality of life measures in COPD

Several general and disease specific quality of life measures have been used to evaluate health-related quality of life for patients with COPD or related pulmonary diseases. Two examples of general health-related quality of life measures are the Sickness Impact Profile (SIP)[4] and the Quality of Well-being scale. The SIP is a profile that describes physical and psychosocial impacts of illness. It has been used in at least four studies involving COPD patients. In the nocturnal oxygen therapy trial (NOTT) the SIP was administered to 203 patients with COPD and 73 healthy controls. In comparison to the controls, COPD patients were significantly more impaired on every scale except employment.[5] In another study of 985 patients with mild hypoxaemia and COPD, mildly affected patients were significantly impaired on most SIP scores with the exception of body movement and eating.[6]

A British version of the SIP known as the Functional Limitation Profile was used in an evaluation by Williams and Bury who reported that only 14% of the variance in patient functioning could be explained by lung function.[7] The Quality of Well-being scale is a general outcome measure that is used to obtain an overall health status score that can be translated into a quality adjusted life year (QALY). The Index number combines assessments of functional mobility,

* To whom correspondence should be addressed

physical activity, and social activity using consumer estimates of relative importance. Studies using the Quality of Well-being scale have shown modest correlations between lung function and quality of life, but more substantial correlations between quality of life and shortness of breath.[8]

Measures of health-related quality of life have also been designed specifically for patients with lung diseases. The Chronic Respiratory Questionnaire (CRQ) developed by Guyatt and colleagues, is a good example. This questionnaire evaluates four aspects of quality of life for patients with lung diseases: dyspnoea, fatigue, emotional function, and mastery. The 20 item questionnaire can be administered in about 15–25 min. In one study it was demonstrated that the questionnaire was responsive to change for 13 patients participating in a drug treatment protocol and 28 patients participating in a respiratory rehabilitation programme. Changes on the questionnaire correlated with changes in spirometric values, exercise performance, and subjective ratings of improvement by both the patients and physicians.[9] In another study, the questionnaire was demonstrated to be sensitive to bronchodilator treatment.[10] Guyatt et al. also administered the CRQ in a pre-test–post-test study on the effects of bronchodilators. At the post-test, half of the patients were shown their previous responses. When patients were given information about their previous responses, changes in CRQ scores for dyspnoea and fatigue were more strongly correlated with changes in spirometry, exercise performance, and subjective ratings of improvement than they were for patients who had not been given the information.[11] Guyatt and colleagues believe this finding supports giving patients feedback on their previous responses. In a fourth study, Jaeschke, Singer, and Guyatt evaluated changes in CRQ scores against changes in global ratings of change. Using global change rating as the criterion, they argued that the CRQ captured clinically important differences.[12]

Despite the advantages of general and disease specific quality of life measures, lung disease specialists have been concerned that global approaches may miss some of the most important outcomes in their patients. For example, several studies have observed low correlations between general quality of life measures of and measures of lung functioning. However, the correlation between quality of life and dyspnoea was substantial. Schrier and colleagues found no correlation between lung function tests and SIP scores. However, they did observe substantial correlations

between symptoms of wheezing and dyspnoea and SIP scores.[13] Yet, the general measures miss many of the subtle characteristics or subtle aspects of the clinically important symptoms. These findings suggest that measures of shortness of breath may be of central importance for evaluating outcomes in COPD. In the next sections the construct of shortness of breath is explored in more detail.

Dyspnoea

Dyspnoea, the clinical term for shortness of breath, is defined as the subjective sensation of difficult or laboured breathing. Dyspnoea is one of the most common and disabling symptoms of people with COPD.[3] The sensation of laboured breathing can be extremely distressing and may be perceived as life threatening in addition to limiting the function and quality of life of people with COPD. While this review focuses on the measurement of dyspnoea in COPD, it should be noted that dyspnoea is a common symptom of other medical conditions as well (e.g. cardiac disease, obesity, neuromuscular disorders affecting the respiratory system).

The sensation of dyspnoea is often accompanied by fear and anxiety.[14] Several authors have described a dyspnoea-panic cycle in which the experience of breathlessness leads to anxiety, which creates muscle tension, leading, in turn, to increased dyspnoea and panic.[14-16] The distress caused by dyspnoea can become part of a vicious cycle leading to fear of future attacks of shortness of breath. This may cause patients with COPD to slowly decrease their activity level resulting in greatly limited independent functioning and quality of life, and furthering the course of deterioration in COPD.[17]

Despite its importance, dyspnoea is not well understood. Dyspnoea represents a complex interplay of physiological and pyschological mechanisms. Dyspnoea correlates only modestly with measures of lung function, and while many theories of physiological mechanisms have been proposed, none has received consistent support.[18] It is not uncommon to encounter patients with mild impairment in lung function who report extreme breathlessness and, on the other hand, patients with severe impairment who report little breathlessness.

There is some evidence that dyspnoea is a central symptom that affects health-related

quality of life for patients with COPD. In one study, a path analysis separated functional status outcomes from more subjective quality of life measures. The analysis suggested that dyspnoea has strong and separate effects for these two outcomes.[19] Another study used the Spanish language version of the Nottingham Health Profile (NHP) in an evaluation of 76 male patients attending an outpatient hospital clinic. Patients with COPD had elevated scores on energy, physical mobility, and sleep disturbance in comparison to the general population. Dyspnoea was the most significant correlate of several NHP dimensions, including energy and physical mobility. Patients with very low levels of dyspnoea reported significant sleep disturbance. Traditional measures of respiratory function were not correlated significantly with NHP dimensions.[20] Dyspnoea is also a common symptom for patients with other chronic conditions. For example, patients with congestive heart failure commonly report dyspnoea and fatigue. Feinstein, Fisher, and Pigeon developed a clinical index of dyspnoea and fatigue specifically for patients with this diagnosis.[21] The index has three components: magnitude of the task that causes the shortness of breath, magnitude of the pace or effort that evokes the problem, and functional impairment. Each dimension is rated on a 5 point rating scale and the scores are summed into a composite index. Feinstein, Fisher and Pigeon regard the measure as an index of quality of life for heart failure patients and have shown the measure to be significantly correlated with patients self-rated improvement resulting from medical therapy. The index may be equally appropriate for patients with COPD.

Although it is agreed that dyspnoea is an important clinical symptom, the measurement of dyspnoea presents several methodological and technical challenges. We will explore some of these issues in the next sections.

Measurement of dyspnoea

Because dyspnoea is a subjective symptom, the ability to measure it has proved difficult. There is no objective criterion against which measures of dyspnoea can be compared. The measurement of dyspnoea is further complicated by the number and variation of available measures, as well as by the various settings in which dyspnoea is measured.

A number of instruments are available to assess dyspnoea, including structured interviews, self-report questionnaires and visual analogue scales. Dyspnoea may be measured in a variety of clinical and research settings. Patients may be asked to give historical reports of dyspnoea experienced during a given period of time or asked to estimate the amount of dyspnoea experienced during various tasks. Dyspnoea may be induced in laboratory or research settings via exercise testing or by the mechanical addition of breathing loads.

Validity criteria for evaluating measures of dyspnoea

Dyspnoea has been described as the sensation of difficult or laboured breathing and is believed to be related to functional, lung function and psychological variables. The validity of a measure of dyspnoea can be established by examining the physiological, psychological, and physical function correlates of the measure. For example, scores on a shortness of breath questionnaire can be correlated with various measures of lung function. To the extent that we expect the construct of dyspnoea to be correlated with lung function, this will provide an estimate of the measure's construct validity. Similarly, we can examine correlations between measures of dyspnoea and measures of anxiety or measures of physical function. The construct validity of a measure of dyspnoea can also be established by evaluating the correlations among the various measures of shortness of breath. If the measures have construct validity (i.e. if they are measuring the same construct), they should be significantly correlated with one another. An examination of the correlates of dyspnoea is also a first step towards further defining the construct.

The literature on dyspnoea measurement reflects a lack of consensus and standardisation. It is difficult to determine which are the most reliable and valid measures for a given setting. And there are few standards for the administration of measures or the induction of dyspnoea. In the following sections, we review some of the more common dyspnoea measures.

Current measures of dyspnoea—description and critique

British Medical Research Council Scale (MRC). This self-report respiratory questionnaire consists

of five questions that pertain to dyspnoea.[22] These questions which are answered yes or no, correspond to a 5-point dyspnoea rating scale developed by Fletcher.[23] Based on the response to these questions, the patient's dyspnoea is rated in terms of one of 5 grades of severity (Grade 1: Not troubled by breathlessness except on strenuous exertion; Grade 2: Short of breath when hurrying on the level or walking up a slight hill; Grade 3: Patient walks slower than most people on the level; Grade 4: Patient has to stop for breath after walking about 100 yards on the level; Grade 5: Too breathless to leave the house, or breathless after undressing). A literature search revealed no reports of the reliability and validity of this measure at the time of its development, yet it has been used extensively since it was introduced in 1960. A more recent study compared the MRC to other measures of dyspnoea and measures of lung function and reported strong correlations of the MRC with other dyspnoea impairment measures ($r = -0.53$––-0.83) and modest correlations with lung function measures ($r = -0.41$––-0.42).[24]

American Thoracic Society Respiratory Questionnaire (ATS). Adapted from the MRC, the ATS is also a self-report respiratory questionnaire which contains five yes–no questions eliciting information about dyspnoea, which are "essentially unchanged from the series included in the MRC".[25] Slight changes in wording are seen in the ATS. For example, Grade 3 on the MRC (Patient walks slower than most people on the level) was changed to, "walks slower than people of the same age on the level". Several pilot studies found the ATS to be acceptable to interviewers and to subjects, and to be satisfactory for self-administration in the general population.[25]

Some investigators have criticised the MRC and ATS because they measure dyspnoea only with regard to magnitude of task, but ignore magnitude of effort and functional impairment.[26,27] The MRC and ATS dyspnoea ratings depend only on the magnitude of the most taxing task that the patient can perform, and no attention is given to the patient's effort in performing tasks or to the functional impairment produced by dyspnoea in everyday activities. This criticism may not be entirely warranted as the MRC/ATS scales do address walking, which in an important functional outcome.

Some studies report using an altered version of the ATS scale, in which the number of points on the rating scale and/or the wording of the scale

have been changed. Concurrent validity has been established in more recent studies which have reported strong correlations ($r = 0.5$ and above) between the MRC/ATS and other measures of dyspnoea and moderate correlations with lung function.[24,27]

Baseline and transition dyspnoea indexes (BDI and TDI)

Mahler *et al.*[28] developed a two-part (baseline and transition), interviewer-administered dyspnoea index that rates dyspnoea according to three categories: functional impairment, magnitude of task, and magnitude of effort. The functional impairment category addresses whether the patient has reduced or given up activities or a job due to shortness of breath. The magnitude of task category rates the type of task that makes the patient breathless (i.e. light *vs* moderate *vs* strenuous tasks). The magnitude of effort category assesses how much effort the patient exerts before becoming breathless (i.e. breathless only after extraordinary exertion *vs* so breathless that s/he has to pause frequently during most tasks).

The baseline dyspnoea index is used to rate the seversity of dyspnoea at a single point in time and the transition dyspnoea index is used to assess changes from that baseline. At baseline, dyspnoea in each of the three categories is rated on a 5-point scale from 0 (severe) to 4 (unimpaired). Ratings for each of the three categories can be added to form a baseline total dyspnoea score (range, 0–12). The transition index is used to rate changes in each of the three categories using a 7-point scale from -3 (major deterioration) to $+3$ (major improvement). Ratings from the transition index can be added to form a dyspnoea transition total score (range, -9–$+9$).

Interobserver agreement for the baseline index has been observed as 92%, while the agreement for the transition index was 90%.[27] A correlation of $r = 0.60$ ($p < 0.001$) was reported between the baseline total score and a 12 min walk test. The transition total score was significantly correlated with the change in 12 min walk ($r = 0.33$, $p < 0.05$). Test–retest reliability has not been reported in any study.

The BDI has been shown to correlate highly with other dyspnoea impairment measures such as the MRC and Oxygen Cost Diagram (OCD, described below) ($r = 0.53 - 0.83$).[24,27] The BDI also

correlated with lung function measures, $FEV_{1.0}$ (forced expiratory volume in 1 s, the volume of air expired from the lungs in the first second of a forced expiratory maneuver), and FVC (forced vital capacity, the total amount of air expired during the forced expiratory maneuver) ($r = 0.43$ and $r = 0.41$, respectively).[27]

The BDI has shown moderate correlations with measures of lung function and strong correlations with other measures of dyspnoea. However, it is not clear that the three categories of the BDI (i.e., functional impairment, magnitude of task and magnitude of effort) add significantly to the measurement of dyspnoea. Mahler criticises the MRC and ATS for not adequately assessing these three areas, yet reports that the BDI and MRC correlate $r = 0.70$, and that the BDI and MRC show similar correlations with measures of lung function. There are two different methods to measure change. First, differences between pre-test and post-test observations can be obtained. Second, subjective estimates of change can be gathered. The BDI uses a subjective assessment of change which is subject to a variety of biases. It is not clear why a separate index to measure change is necessary. If the BDI is reliable and valid, then it could be used for repeated measures of dyspnoea.

The BDI and TDI are somewhat difficult to use as part of a standardized research protocol. For example, the TDI mandates that the interviewer have on hand the patient's baseline scores as well as a copy of the BDI. The TDI refers back to the patient's state at baseline, and the wording of the magnitude of task category refers the interviewer back to the levels described on the BDI, which are not described on the TDI. The TDI is likely affected by bias on the part of the patient and the interviewer as it asks both patient and interviewer to rate changes in the patient's status since baseline.

Modified Dyspnoea Index (MDI)

This interviewer-administered questionnaire represents a modification by Stoller *et al.*[18] to the Baseline Dyspnoea Index developed by Mahler *et al.*[26,28] Modifications include greater clarification of rating scale points, with more examples given for each. The functional impairment category was divided into impairment at work and impairment at home. And the rating scale for each category was changed from a 5-point to a 4-point scale.

Stoller *et al.*[18] report that the MDI has a strong correlation with $FEV_{1.0}$ and FVC ($r = 0.71$ and $r = 0.69$, $p < 0.0001$, respectively), but a small and nonsignificant correlation with the 12 min walk test. Interobserver and test–retest reliability were not reported.

Both the MDI and the BDI gain a total score by adding together raw scores from the three subcomponents. Forming an index by adding gives each dimension equal weight. Yet, it is uncertain that these dimensions should be treated as equally meaningful. While the revisions to the BDI provide some clarification to the categories of the BDI, the MDI was not validated against its predecessor, thus the effect of the modification is unknown. A literature search revealed only one study in which the MDI was used.

Oxygen Cost Diagram (OCD)

The oxygen cost diagram is a 10 cm line along which activities are written at intervals which correspond to the metabolic equivalents (or oxygen cost) required to perform them.[29] Patients are asked to make a mark on the line indicating the point above which their breathlessness would not allow them to go. Examples of activities on the diagram are 'brisk walking uphill', 'medium walking on the level', 'bed making', 'standing', and 'sleeping'. McGavin *et al.*[29] reported that patient's ratings of breathlessness using the oxygen cost diagram were correlated $r = 0.68$ ($p < 0.001$) with the 12 min walk test, but not with $FEV_{1.0}$. The OCD has shown strong correlations with other dyspnoea impairment measures ($r = -0.53$– -0.79).[27,28] Finally, our experience in administering the OCD suggests that many patients do not understand how to rate the scale according to its printed instructions, necessitating alternate ways of explaining the scale and further need of standardizing instructions.

In addition to the above measures, two additional dyspnoea measures are available. These are the visual analogue scale and the Borg scale. These scales have two modes of administration. Most often, they are used to obtain dyspnoea ratings during a task which produces breathlessness, such as an exercise test. However, patients are sometimes asked to use these scales to rate their current level of dyspnoea or to give historical reports of dyspnoea experienced during a given period of time or during a specified task.

Visual Analogue Scale (VAS)

The VAS is presented to the subject as a 10 cm vertical or horizontal line, sometimes accompanied by anchors, such as 'not at all breathless', and 'very breathless'. Subjects are instructed to place a mark on the line indicating their level of breathlessness. The reliability and validity of the VAS have been evaluated for the use with a dyspnoea-producing task, but have not been assessed for administration without such a task (i.e. to obtain historical reports of dyspnoea for a given task or for a given time period).

The validity of a visual analogue scale (VAS) to measure respiratory sensations was first described by Aitken in 1969.[30] He reported that dyspnoea ratings using the VAS increased as the resistive load of breathing was experimentally increased. Using a within-subjects design and five patients with COPD, Stark, Gambles and Chatterjee demonstrated that breathlessness ratings using the VAS increased progressively with the level of ventilation during a treadmill exercise test.[31] They also stated that their data showed acceptable test–retest reliability of the VAS, although statistical analysis was not performed and examination of the individual plots of the VAS against ventilation shows variability. Stark, Gambles and Lewis reported that VAS ratings of dyspnoea were associated with heart rate, oxygen uptake and respiratory rate.[32] Concurrent validity was demonstrated in a study in which patients with asthma rated their dyspnoea on both a vertical and a horizontal VAS, and then measured their peak expiratory flow rate (PEFR).[33] Correlation between the vertical and horizontal scales was $r = 0.97$, and between the vertical VAS and PEFR $r = -0.85$. Discriminant validity was established by having the patients rate their dyspnoea on the vertical VAS during times of severe and little airway obstruction. Dyspnoea ratings were found to be significantly different at times of severe and low obstruction ($p < 0.01$).

Test–retest reliability of VAS ratings during exercise was evaluated by Wilson and Jones.[34] They reported that VAS (and Borg scale) dyspnoea ratings were stable across repeat testing during a single exercise session, but that dyspnoea ratings decreased significantly from one exercise test to the next when the trials were repeated 2 weeks apart ($p < 0.01$).

In terms of face validity, the VAS appears to provide a straight forward method of quantifying the perception of dyspnoea. A potential problem with the VAS revolves around its various modes of administration. Its use without a dyspnoea-producing task (i.e., to obtain historical reports) has not been evaluated. When the VAS is used with an exercise task, questions remain about the reproducibility of the dyspnoea ratings obtained. Also, as discussed with the Borg scale (below), the reliability of VAS dyspnoea ratings may vary across different dyspnoea-inducing or exercise tasks. There are no standards for anchoring the ends of the scale, and the effects of various methods of anchoring have not been explored.

Borg scale

The modified Borg scale is a 0 to 10 rating scale (0 = none, 10 = maximum) on which patients are asked to rate their level of breathlessness.[35] Written descriptors are placed so that a doubling of the numerical rating corresponds to a two-fold increase in sensation intensity. The original Borg scale ranged from 6 to 20, also with written descriptors, and was revised to give this essentially categorical scale the properties of a ratio scale.[36] In a summary of various studies using the original Borg scale to rate perceived exertion, Borg reported correlations between the scale ratings and heart rate in the range of $r = 0.80$–0.85. Burdon *et al.* reported a correlation between breathlessness ratings and $FEV_{1.0}$ of $r = 0.88$, although they noted that there was substantial variability in the ratings of breathlessness for any given level of $FEV_{1.0}$.[37]

Belman *et al.* evaluated the reproducibility of modified Borg scale ratings of dyspnoea in nine patients with COPD.[38] The patients completed four 6 min treadmill walks on four separate days during a 10 day period. The authors reported that while the physiological parameters measured stabilized after one or two walks, the Borg scale ratings decreased significantly with successive tests. In a similar study, Wilson and Jones found that Borg scale ratings during exercise testing decreased from one test to the next when the trials were repeated 2 weeks apart but not when repeated on the same day.[34] These studies demonstrate the difficulty in attempting to assess the reliability of Borg scale (and VAS) ratings when the ratings are tied to a task that is subject to learning effects and when the subjects may experience desensitisation to the symptom of dyspnoea. The reliability of Borg and VAS ratings during various dyspnoea-producing tasks is in need of further

investigation. The reliability and validity of Borg and VAS ratings to obtain current or historical dyspnoea ratings has not been evaluated.

Comparison between the VAS and Borg scales

Wilson and Jones compared Borg and VAS ratings during two exercise testing sessions conducted 2–6 weeks apart on a sample of 10 healthy subjects.[34] They reported that the range of scores was greater for VAS ratings than Borg scale ratings, with fewer subjects using the upper half of Borg scale. Borg and VAS ratings were correlated $r = 0.71$, while the mean ratings for each scale were significantly different. Similar to the findings of Belman *et al.*, Wilson and Jones found that ratings for both scales were significantly lower on

the second testing day than on the first, with the mean Borg scale rating decreasing by 16% and the mean VAS rating decreasing by 27%.[34,38]

Correlates of dyspnoea

Physiological correlates

Numerous authors report that dyspnoea is not strongly correlated with objective measures of pulmonary function.[13,20,31] Table 1 lists a number of studies which have examined the correlation between various measures of dyspnoea and measures of pulmonary function, such as $FEV_{1.0}$, FVC, and peak expiratory flow rate (PEFR).[24,26–28,33,37,39,41,42] Looking at the measures of dyspnoea as a group, correlations with lung function variables range from low and nonsignificant to quite strong. The physiological correlates of

Table 1. Physiological correlates of dyspnoea

Study	Population	No Ss	Measure	Correl. w/FEV$_1$	Correl. w/FVC	Correl. w/PEFR
1. Mahler & Wells (1988)	COPD & misc	153	MRC OCD BDI	−0.42** 0.16 0.43**	−0.41** 0.16 0.41**	
2. Mahler *et al.* (1987)	COPD	24	MRC OCD BDI	−0.44* 0.46 0.46*	−0.43* 0.49* 0.47*	
3. Mahler *et al.* (1984)	COPD, Asthma, Interstl fibrosis	38	BDI TDI	0.41* −0.04	0.56* −0.01	
4. Stoller *et al.* (1986)	COPD	32	MDI	0.71*	0.69*	
5. Burdon *et al.* (1982)	Asthma	45	Borg	0.88		
6. Williams & McGavin (1980)	COPD	20	VAS	0.35	0.72**	
7. Burrows *et al.* (1965)	COPD	175	Perceived dyspnoea/ dyspnoea impairment (both unspecified)	−0.62*/ −0.37*	−0.50*/ −0.21	
8. Gift (1989)	Asthma	16	VAS (vertical) VAS (horizontal)			−0.85 −0.71
9. Gift *et al.* (1986)	Asthma	11	VAS (vertical) VAS (horizontal)			range −0.06−−0.96 range −0.27−−0.89

*$p < 0.05$
OCD = Oxygen Cost Diagram
MDI = Modified Dyspnoea Index
**$p < 0.01$
BDI = Baseline Dyspnoea Index
MRC = Medical Research Council Scale
VAS = Visual Analogue Scale
TDI = Transition Dyspnoea Index
Borg = Borg Scale

any one measure are difficult to evaluate because most measures were used in only one or two studies. The MRC and BDI, both used in two studies, show consistently modest correlations with FEV1 and FVC. The differences in correlations seen in Table 1 may reflect variations in the range of patient illness from study to study. Studies with a broader range of patient illness have the potential to find higher correlations between lung function and dyspnoea. However, this is difficult to evaluate as the lung function measures and the statistics used to quantify them varied across studies. Overall, Table 1 shows a fair degree of consistency among studies indicating that dyspnoea correlates modestly with lung function measures.

Psychological correlates

Table 2 displays studies examining the psychological correlates of dyspnoea. We searched the literature for studies of the relationship between dyspnoea and a broad range of psychological constructs (i.e., from anxiety and depression to emotional distress).[16,39,43,44] While it has been proposed that the anxiety associated with dyspnoea may be the factor that most impairs quality-of-life in patients with COPD,[14] few studies have empirically evaluated dyspnoea and its psychological correlates. Renfroe reported a correlation of $r = 0.60$ between anxiety and dyspnoea.[16] Gift et al. found significant differences in anxiety, somatisation and symptom distress corresponding to patients' level of dyspnoea (high, medium, low).[39] Burns and Howell found that 'disproportionate breathlessness' was associated with depression and anxiety.[43] However this definition of breathlessness was based solely on a level of $FEV_{1.0}$ and not on patient reports. Given that the literature reflects only modest correlation between $FEV_{1.0}$ and dyspnoea, this definition of disproportionate breathlessness is questionable. Dudley et al. had subjects relax and then instructed them to think about an unpleasant event findings that dyspnoea was associated with emotional and physiological changes.[44] There was no verification of subjects' emotional state during this manipulation. In the only study to empirically evaluate the complexity of intercorrelations among dyspnoea, disease severity, mastery, depression, functional status and quality-of-life, Moody and colleagues concluded that dyspnoea was more strongly related to a psychological variable (i.e. mastery) than to disease severity.[19] Although studies do link dyspnoea to psychological variables, these preliminary findings require replication and further exploration.

Table 2. Psychological correlates of dyspnoea

Study	Population	No SS	Measure	Correlates
1. Renfroe (1988)	COPD	12	VAS	Reported correlation of $r = 0.60$ between VAS & Spielberger State Anxiety Scale.
2. Gift et al. (1986)	COPD	20	VAS	Reported significant differences in anxiety, somatisation & symptom distress in three levels of dyspnoea (low, medium, high).
3. Burns & Howell (1969)	COPD & heart disease	62	MRC	Compared 31 patients w/'disproportionate breathlessness' (DB) to 31 controls with proportionate breathlessness, matched for level of breathlessness. Reported significantly more frequent depression, anxiety and hysterical reactions in DB group.
4. Dudley et al. (1968)	COPD & TB Normals	16 20	unspecif	Following manipulation of emotional state, found that dyspnoea was associated with both emotional and physiological change and not limited to patients with pulmonary disease.
5. Moody et al. (1990)	COPD	45	VAS	Dyspnoea was more strongly related to psychological variable of mastery than to disease severity.

VAS = Visual Analogue Scale
MRC = Medical Research Council Scale

Physical function correlates

Studies exploring physical function correlates of dyspnoea are shown in Table 3.[28,29,41,45] The distance a patient can walk in a specified time period (i.e. 6 or 12 min) is the most common functional outcome variable reported in the literature. Although results are inconsistent, there is a clear trend toward positive correlations between dyspnoea and the 12 min walk. The varying correlations do not appear to be a result of variations in range of distance walked across studies, given the similarities in the means and standard deviations reported in three of the four studies. Dyspnoea appears to be moderately correlated with walking measures of functional ability. Given the importance of functional outcomes in pulmonary rehabilitation, the relationship of dyspnoea to other measures of function or behavioural outcomes deserves further study.

Correlations among measures of dyspnoea

Table 4 displays the results of studies examining correlations among measures of dyspnoea.[24,26,27,33,39,45] As would be expected, the vertical and horizontal visual analogue scales are highly correlated. Correlations among dyspnoea impairment measures are moderate to high, indicating that there is some degree of consistency in the construct being measured by these scales.

Summary and conclusions

Dyspnoea is an important factor in quality of life for patients with COPD. The understanding of the dyspnoea construct and the ability to measure it are in need of further exploration. Currently, there is inadequate information to determine the most reliable and valid dyspnoea measures. Also, the methods for administering the various measures are not well standardised.

The physiological, psychological, and physical function correlates of the various measures of dyspnoea are difficult to evaluate. Most measures were used in only one or two studies, patient populations were sometimes mixed, and the methodologies and information reported across studies were, at times, so varied as to preclude combining findings across studies. Half of the studies exploring the correlates of visual analogue scales have been conducted with patients with asthma. Patients with asthma have acute episodic attacks of dyspnoea, thus it may not be appropriate to generalise these findings to patients with COPD who have chronic unremitting dyspnoea at rest or at moderate levels of exercise.[13] Despite these difficulties, the degree of correlation among measures of dyspnoea indicates that there is some consistency in the construct being measured by these scales. Dyspnoea correlates modestly with measures of pulmonary function and with the 12-min walk. The observed relationship between dyspnoea and psychological factors is in need of further investigation.

There is little consensus as to which dyspnoea

Table 3. Correlations between dyspnoea and 6 or 12 min walk tests

Study	Population	No Ss	Measure	Correlation w/ 6 min walk	Correlation w/ 12 min walk
1. Guyatt *et al.* (1985)	Heart & lung disease	43	OCD BDI	0.46** 0.59**	
2. McGavin *et al.* (1978)	Airway obstruction & pulmonary infiltration	62	OCD		0.68**
3. Williams & McGavin (1980)	COPD	20	VAS		0.38
4. Mahler *et al.* (1984)	COPD, asthma, interstitial fibrosis	38	BDI TDI		0.60** 0.33**

*$p < 0.05$
**$p < 0.01$
OCD = Oxygen Cost Diagram
BDI = Baseline Dyspnoea Index
VAS = Visual Analogue Scale
TDI = Transition Dyspnoea Index

Table 4. Correlations among measures of dyspnoea

Study	Population	No Ss	Measures	Correl
1. Gift (1989)	Asthma	16	VAS (vertical) VAS (horizontal)	0.97
2. Gift *et al.* (1986)	Asthma	11	VAS (vertical) VAS (horizontal)	range: 0.52–0.99
3. Guyatt *et al.* (1985)	Heart & lung disease	43	BDI OCD	0.59**
4. Mahler & Wells (1988)	COPD & misc	153	MRC-OCD MRC-BDI BDI-OCD	−0.53** −0.70** −0.54**
5. Mahler *et al.* (1987)	COPD	24	MRC-OCD MRC-BDI BDI-OCD	−0.71** −0.83** −0.79**
6. Stoller *et al.* (1986)	COPD	32	MDI-PRU	−0.62

*$p < 0.05$
**$p < 0.01$
OCD = Oxygen Cost Diagram
BDI = Baseline Dyspnoea Index
VAS = Visual Analogue Scale
TDI = Transition Dyspnoea Index
MDI = Modified Dyspnoea Index
PRU = Pneumoconiosis Research Unit Scale (similar to MRC)

measures are most appropriate for a given clinical setting. We recommend the Visual Analogue Scale and Borg Scale for evaluating dyspnoea during exercise testing or to desensitise patients to the sensation of dyspnoea during exercise training. Mahler's Baseline Dyspnoea Index and the Medical Research Council/American Thoracic Society Scale may be most useful in measuring overall impairment due to dyspnoea and for setting goals for improved function. Dyspnoea measures should be chosen based on their reliability and validity, and efforts to standardize administration of the measures should be described in subsequent research reports. The research agenda should include continuing validity assessment of the various measures. Further studies evaluating the relationship between dyspnoea and everyday activities are needed.

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