Functional Tests in Chronic Obstructive Pulmonary Disease, Part 1:
Clinical Relevance and Links to the International Classification of Functioning, Disability, and Health

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Abstract

Chronic obstructive pulmonary disease is a major cause of morbidity and mortality worldwide and an important cause of disability. A thorough patient-centered outcome assessment, including not only measures of lung function, exercise capacity, and health-related quality of life, but also functional capacity and performance in activities of daily life, is imperative for a comprehensive management of chronic obstructive pulmonary disease. This American Thoracic Society Seminar Series is devoted to help clinicians substantiate their choice of functional outcome measures in this population. In Part 1 of this two-part seminar series, we describe the various domains of functional status to elucidate terms and key concepts intertwined with functioning and to demonstrate the clinical relevance of assessing functional capacity in the context of activities of daily living in agreement with the International Classification of Functioning, Disability, and Health. We hope that a better understanding of the various defining components of functional status will be instrumental to healthcare providers to optimize chronic obstructive pulmonary disease evaluation and management, ultimately leading to improved quality of life of patients afflicted by this condition. This first article also serves as an introduction to Part 2 of this seminar series, in which the main functional tests available to assess upper and lower body functional capacity of these patients are discussed.

Keywords: patient outcome assessment; functional capacity; functional performance; International Classification of Functioning, Disability, and Health

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With 210 million individuals affected worldwide, chronic obstructive pulmonary disease (COPD) is the fourth leading cause of death. For people living with severe COPD, the disease imposes an enormous burden of disability and impaired quality of life (1).

Even though COPD is primarily a disease of the respiratory system, impaired respiratory function is only one aspect of the disability experienced by individuals with COPD. In addition to expiratory flow limitation and dyspnea, patients with COPD often have comorbidities such as cardiovascular diseases, osteoporosis, limb muscle dysfunction, and psychological disorders, all of which contribute to limited capacity and restricted participation in physical and emotional activities of daily life (2, 3), and as a consequence, to a poor health-related quality of life (4–8).

Pulmonary rehabilitation relieves dyspnea and fatigue, improves exercise capacity and emotional function, and enhances the sense of control individuals have over their health condition (7, 9). Thus, pulmonary rehabilitation is now recognized as a core component for the management of chronic respiratory diseases (7). Because this intervention also aims to improve patients' ability to carry out daily tasks and to fulfill their social roles, measuring patient-centered outcomes such as activities of daily life and participation beyond the sole assessment of body structures and functions such as expiratory flows, and maximal oxygen consumption based on cardiorespiratory exercise testing is crucial. Clinicians should thus be aware of existing and validated evaluation tools that are representative of patients' global functioning, and not only of their exercise tolerance.

The World Health Organization recommends the use of the International Classification of Functioning, Disability, and Health (ICF) to comprehensively assess the health experience of patients living with specific health conditions (10, 11). This classification uses globally agreed-on language and reflects the biopsychosocial model in a unified view of various dimensions of health (11).

In the first part of this two-part *Annals* seminar series, we demonstrate the clinical relevance of globally assessing function in patients with COPD. In agreement with the ICF framework, the approach we advocate includes evaluation of the three distinct dimensions of bodily function: exercise capacity, functional capacity, and functional performance. This first article serves as an introduction to the second part of this seminar series, in which the main functional tests available to assess upper and lower body functional capacity and their clinical relevance in different contexts of COPD management are discussed to help health care professionals substantiate their choice of functional tests in clinical practice or in laboratory settings.

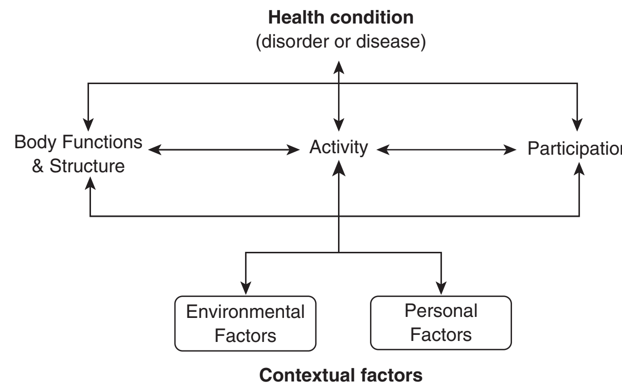

Figure 1. The World Health Organization's International Classification of Functioning, Disability and Health framework (11). Adapted and printed here under a Creative Commons license (https://creativecommons.org/licenses/by/4.0/).

International Classification of Functioning, Disability, and Health

Based on the work of Nagi (12, 13), the ICF was developed by the World Health Organization to provide a comprehensive framework of definitions and structures for rehabilitation (14), allowing a patient-centered outcome assessment, including not only body structures and functions but also patient functioning in activities and participation. In this model, the whole health experience of the individual is considered, rather than a limited focus on pathophysiological aspects of diseases.

The Five Domains of Function and Disability

As illustrated in Figure 1, the ICF framework presents functioning and disability of an individual with a given health condition as the interaction between five different domains: body functions and structures, activities, participation, environmental, and personal factors.

Body functions and structures domain refers to the anatomical and physiological functions of the different body systems. Deficits in this domain are called "impairments" (e.g., airflow obstruction, muscle weakness, poor cardiorespiratory fitness). The activity domain describes the ability of an individual to perform specific and isolated tasks. Decrements in this domain are called "limitations" and describe the difficulty an individual experiences when performing a particular task in a controlled environment (e.g., walking up a sloping surface, putting down objects, raising up objects to a higher level) (11).

The participation domain describes one's ability to be involved in life situations. Participation restrictions describe the reduced ability of a person to maintain normal role functions and interact with society (e.g., performing different tasks in a given time for a remunerated employment, engaging in recreational or leisure activities, taking care of plants indoors or outdoors) (11).

Finally, the contextual factors, which include the environmental (e.g., air quality, products or substances for personal consumption) and personal (e.g., age, psychosocial status, ethnicity) factors are directly linked to the first three domains and complete this framework. Unlike other existing classifications, ICF sets the ground for a standard language when describing disability (15). This language standardization is relevant and important to describe the functioning of patients with COPD and improve communication between all individuals who could potentially be involved (e.g., patients, families, health and social professionals, researchers, and policy-makers) in the development of a comprehensive interdisciplinary rehabilitation plan of care (15). Therefore, guidelines in COPD management and rehabilitation could appropriately be designed and put into action based on this ICF framework.

The Comprehensive Core Set

In 2004, 17 experts from eight countries with various professional backgrounds developed an ICF Comprehensive Core Set for multidisciplinary assessment in patients with obstructive lung diseases (under which COPD is the most representative worldwide) (16). This Core Set has been developed from a formal decision-making and consensus process integrating evidence gathered from preliminary studies including a Delphi exercise, a systematic review, and an empirical data collection using the ICF checklist (16). It includes 19 categories from the domain "body functions," five from "body structures," 24 from "activities and participation," and 23 from "environmental factors." Personal factors were not classified by this initiative (16).

According to the Comprehensive ICF Core Set, the most frequent impairments in body structures and functions in patients with COPD are the structure and function of respiratory system (100%), exercise tolerance (100%), structure of cardiovascular system (83%), sensations associated with cardiovascular and respiratory functions (92%), limb muscle function (50%), and structure of the trunk (50%) (16). The most frequent limitations in activities and participation were walking (100%), moving around (100%), carrying out daily routine (58%), doing housework (58%), and dressing (50%) (16). In line with the focus of this article, relevant ICF components adapted from this Core Set and that are commonly assessed in COPD are presented in Figure 2.

Assessment of Physical Components of Functional Status in Patients with COPD

Although recognizing that environmental and personal factors (which includes

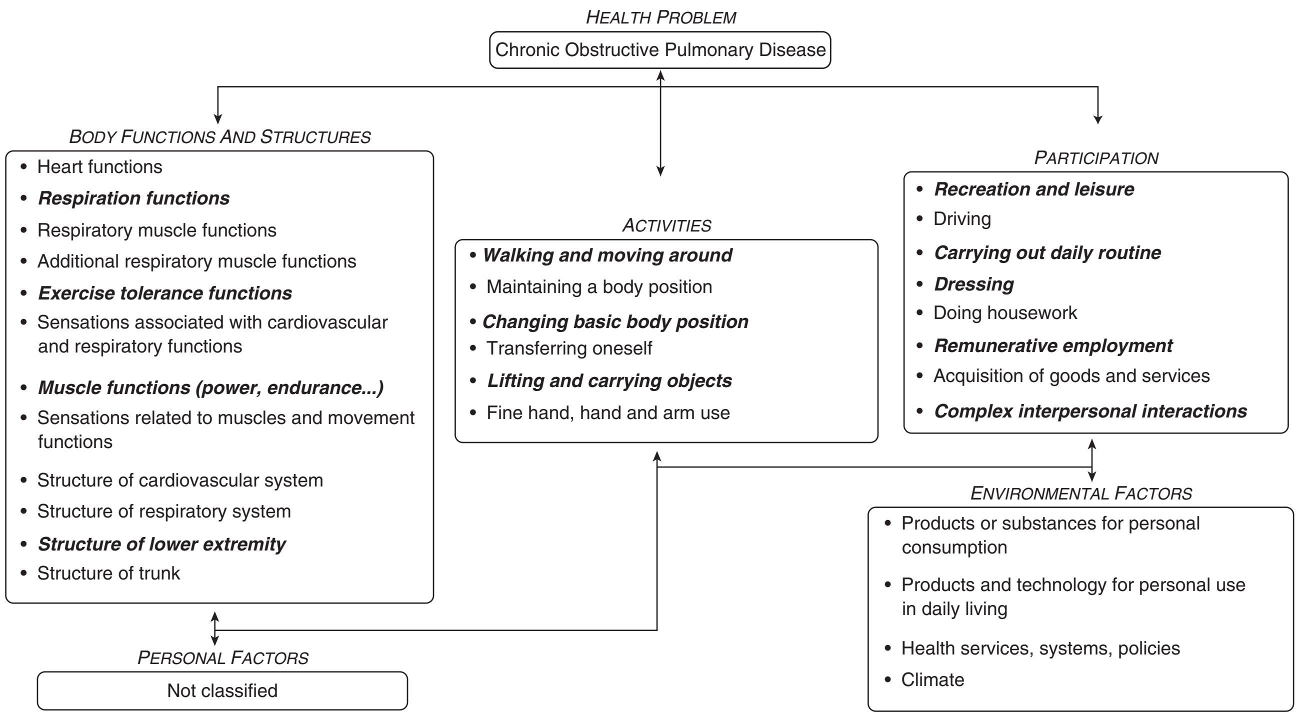

Figure 2. Adapted from the ICF Comprehensive Core Set from Stucki and colleagues (16). Components in bold include examples of commonly used outcomes in chronic obstructive pulmonary disease and are presented with examples of associated tests and outcomes in Table 2.

psychosocial factors) associated with chronic respiratory diseases have an effect on functional status and participation in daily activities, this seminar series puts the emphasis on the physical dimension of functional status. Regarding the physical components of functioning, the ICF framework and Core Sets lead to the evaluation of three closely interrelated but distinct concepts (exercise capacity, functional capacity, and functional performance; Figure 3), each of which refers to a specific domain (body structure and function, activities, and participation, respectively).

Exercise capacity refers to one's physiological maximal response to exercise (e.g., maximal oxygen consumption or heart rate) or the body structure's maximal ability to fulfill its own function (e.g., maximal voluntary contraction of a skeletal muscle). Functional capacity is defined as one's maximal potential to realize a functional activity in a standardized environment (e.g., walking distance during the 6-minute-walk test).

Functional performance refers to the ability to complete "the physical, psychological, social, occupational, and spiritual activities that people actually do in the normal course [and context] of their lives to meet basic needs, fulfill usual roles, and maintain their health and well-being" (e.g., ability to get dressed without help) (7, 17). Functional performance thus refers to participation in daily life activities and is usually performed at a level that does not require nor meet maximal exercise capacity. Examples of commonly used outcomes and associated tests hinged on the ICF components and categorized according to the different key concepts to which they refer are presented in Table 1. A greater physiological exercise capacity will likely result in a greater maximal potential ability to realize functional activities, and thus patients should perform a daily functional task more easily (e.g., in a lesser time, with less dyspnea [better functional performance]).

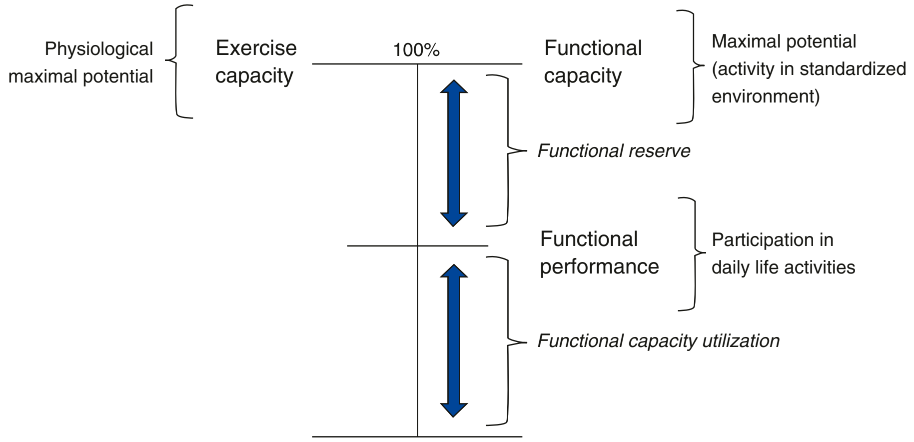

Figure 3. Key concepts of exercise capacity, functional capacity, and functional performance framework. Adapted from Reference 17.

Table 1. Examples of commonly used outcomes in chronic obstructive pulmonary disease and associated tests hinged on the ICF components

	Exercise Capacity		Functional Capacity			Functional Performance		
Body Structures and Functions	**Tests**	**Outcomes**	**Activities**	**Tests**	**Outcomes**	**Participation**	**Tests and Questionnaires**	**Outcome(s)**
Respiration function	Spirometry, plethysmography (lung volumes)	FEV_1, FVC, TLC, IC	Walking	6MWT, ESWT	Maximal distance walked, time walked at the given speed	Recreation and leisure	Pedometer	Number of daily steps (physical activity quantification)
Exercise tolerance function	Incremental and endurance CPET	$\dot{V}O_2max$, time at a constant work rate	Moving around (climbing)	Glittre ADL test, 3MST, SCPT	Time to complete five laps, number of steps ascended and descended, time and velocity during the ascension	Carrying out daily routine	Pulmonary Functional Status and Dyspnea Questionnaire	Level of dyspnea during daily activities
Muscle function (power, endurance)	Isometric, isotonic, or isokinetic measurements of voluntary/nonvoluntary contractions, surface electromyography	Peak muscle torque, total amount of work performed, time to exhaustion, twitch force	Changing basic body position	5STS, GST, TUG	Test duration	Dressing, remunerative employment, recreation, and leisure	Canadian Occupational Performance Measure	Ability (score on a 1–10 scale) to perform significant problematic activities
Structure of lower extremity: muscles of the thigh	Computed tomography, bioelectrical impedance, biopsy	Muscle mass, midthigh cross-sectional area	Lifting and carrying objects	6PBRT, UULEX	Number of rings moved, test duration, and weight of the heaviest bar lifted	Complex interpersonal interactions, remunerative employment	London Chest Activity of Daily Living	Ability (score on a 1–5 scale) to perform without help daily activities

Definition of abbreviations: 3MST = 3-minute constant rate step test; 5STS = five-repetition sit-to-stand; 6MWT = 6-minute-walk test; 6PBRT = 6-minute pegboard and ring test; CPET = cardiopulmonary exercise test; ESWT = endurance shuttle walk test; Glittre ADL test = Glittre Activities of Daily Life test; GST = grocery shelving test; IC = inspiratory capacity; SCPT = stair climb power test; TLC = total lung capacity; TUG = timed up and go; UULEX = unsupported upper limb exercise test; $\dot{V}O_2max$ = maximal oxygen consumption.

Exercise Capacity

In patients with COPD, exercise tolerance tests include the incremental or constant walking or cycling tests, measurement of voluntary or nonvoluntary maximal muscle contractions, spirometry, and field walking tests. Exercise tolerance tests are often used to assess objectively a patient's exercise capacity and response to, and efficacy of, pulmonary rehabilitation.

Table 1 presents examples of exercise capacity tests for various body structures and functions. Field walking tests are, however, primarily considered to assess functional capacity, as explained in the next section. Often used as a surrogate to determine functional capacity, maximal exercise tests, such as incremental and constant cycling and walking tests, are usually performed with comprehensive monitoring of cardiopulmonary variables, providing precise indications of maximal and submaximal exercise capacity and of the physiological responses to exercise, in addition to being useful for prognostication of patients with respiratory diseases (18).

Exercise capacity tests are especially useful for quantifying exercise tolerance, determining mechanisms of and contributors to exercise limitation, and prescribing the exercise training regimen to be used during pulmonary rehabilitation. They can predict coexisting or alternative conditions, as well as patients' prognosis in terms of the likelihood of exacerbations, hospitalizations, and even mortality (4, 19, 20). However, they do not evaluate limitations (activities domain) or the ability to perform daily activities (participation domain) of the ICF Framework (18). Thus, in addition to maximal exercise tests, activity and participation domains need to be addressed with specific tests as representative as possible of one's functional status.

Functional Capacity

Field walking tests are low cost, require little equipment, and are considered to be more reflective of daily life than laboratory-based treadmill or cycle ergometer tests. Although these tests were developed to evaluate functional capacity and indicate one's maximal ability to conduct a functional activity (in that case walking), they can also measure exercise capacity by providing physiological measures when cardiopulmonary variables are monitored (body functions).

The most recognized test is the self-paced 6-minute-walk test (7, 19–21), which has been used in many clinical trials of pulmonary rehabilitation in COPD (22). The incremental shuttle walk test and the endurance shuttle walk test are externally paced field walking tests (23, 24). These two tests are considered more standardized than the 6-minute-walk test, as the walking speed is set, and thus less influenced by motivation, self-selected pacing, or variability of instructions provided. The incremental shuttle walk test is a true symptom-limited maximal exercise capacity test, as the distance walked relates strongly to peak aerobic capacity (25). The endurance shuttle walk test is a constant walking speed test performed at a set speed based on performance during the incremental shuttle walk test: it cannot, therefore, be conducted independently from the latter. The outcome of the total distance covered in these two tests is also a good indicator of one's functional capacity, as it presents the maximal distance a person can walk at a given speed.

Because a large variability in individual goals and physical limitations is present in patients with chronic respiratory diseases, walking may not always be a significant functional activity for the individual patient. Indeed, a large study suggested that up to one-third of individuals with COPD do not describe walking as an important goal (8). In this context, there is a growing interest in the use of functional tests that evaluate patient's functional capacity in activities other than walking. These tests were often designed and developed for aging populations, but their use is also gaining popularity in chronic respiratory diseases.

To be reflective of functional performance and to adequately assess functional capacity, functional tests need to be performed in a standardized environment and should include components of the ICF focusing on physical functional activities such as maintaining a standing position, changing basic body position, walking, and moving, as well as carrying, moving, and handling objects, as referred to in the ICF Chapter 4, "Mobility" (11). The most commonly used or recommended tests to assess upper and lower body functional capacity and functional performance in patients with COPD are listed in Table 2. Their specific methodologies, metrological characteristics, strengths, and weaknesses are reviewed in depth in Part 2 of this seminar series.

Table 2. Functional tests commonly used in chronic obstructive pulmonary disease and further described in the second part of this seminar series

Abbreviation	Name
3MST	3-minute constant rate step test
4MGS	4-m gait speed
5STS	Five-repetition sit-to-stand
6MST	6-minute step test of free cadence
6MWT	6-minute walk test
6PBRT	6-minute pegboard and ring test
BBS	Berg Balance Scale
ESTW	Endurance shuttle walk test
Glittre ADL test	Glittre Activities of Daily Life test
GST	Grocery shelving task
SCPT	Stair climb power test
SPPB	Short physical performance battery
TUG	Timed up and go
UULEX	Unsupported upper limb exercise test

Functional Performance

Because of the large variability in the effect of COPD on given individuals, none of the functional capacity tests could possibly be considered as the perfect surrogate of real functional status and functional performance of patients with COPD. Moreover, as functional performance should be considered as a whole with context (which includes physical and social environments), no laboratory-based tests are fully representative of patients' true ability to fulfill their social roles, as laboratory and often clinical contexts obviously differ on several aspects (e.g., distractions, physical environment, direct or indirect pressure from evaluators) from the real-life situations in which patients usually perform their activities.

To have a better idea of all the intricate dimensions that are involved, functional performance could be assessed using both direct observation of daily life activities in patients' real environment and/or questionnaires such as the Pulmonary Functional Status and Dyspnea Questionnaire (26), the Pulmonary Functional Status Scale (short form) (27), the London Chest Activity of Daily Living (28), and the Canadian Occupational Performance Measure (29).

It is also feasible to quantify physical activity in daily life (defined as the totality of voluntary movements produced by skeletal muscles during everyday functioning [30]) and activity in both healthy adults (30, 31) and those with chronic obstructive pulmonary diseases (32). As previously detailed (3), various technologies have been developed in recent years, integrating various motion sensors with different devices such as pedometers, watches (e.g., Fitbit [33]), and activity monitors (34–36) to quantify duration, frequency, and intensity of physical activity). Pedometers are portable devices usually worn at the belt/hips height that count the number of steps taken by an individual during the day.

The main advantages of pedometers are a low cost (37–39), an ease of use, easy-to-view data, and good insight into the patients' daily functional status (40). These devices may, however, underestimate the level of physical activity in patients walking at low speed, where pedometers may be less sensitive to detect movements (41, 42). Furthermore, pedometers give only a glimpse of functional performance in daily life situations that involve walking activities, and do not capture other significant functional activities for patients. Numerous watches that keep track of the number of steps taken in the day, calories spent, and distance walked, for example, were also recently put on the market, but validation studies are still lacking. The reader is invited to refer to the recently published European Respiratory Society statement on physical activity (43), which provides a comprehensive review of the topic.

Clinical Relevance of Assessing Activities Limitations, Using Functional Tests

The present article highlights the need for understanding the specific utility of functional tests to assess activity limitations, as also considered in a recent perspective by Nyberg and colleagues (44). In patients with COPD, exercise capacity during cycling or walking tests is often used as a surrogate for functional performance; however, in agreement with the ICF developed by the World Health Organization, exercise capacity is only one aspect of functioning. Because these laboratory or field tests evaluating exercise capacity do not provide an adequate assessment of the limitations when performing significant daily activities, the use of functional tests is encouraged for a comprehensive management of patients with COPD. By allowing identification of specific limitations in tasks that are relevant to daily living, such as standing and carrying or handling objects, functional tests should lead to better individualized rehabilitation interventions that should also be more effective in translating their benefits in daily life, ultimately resulting in optimized health status and quality of life for the patients.

Because functional tests have been specifically designed to assess the ability of an individual to perform specific tasks of daily living in a controlled environment, they are suited in COPD to link how impaired body structure and function translates into reduced participation and ability to interact adequately within the society. These functional tests should be particularly useful in the context of pulmonary rehabilitation, where improving functional status and participation in daily life is actively sought (7). Interestingly, many of these tests have demonstrated responsiveness to pulmonary rehabilitation (45–51) and could be used to assess the response to this therapeutic intervention.

The complexity of some functional tests (such as the walking or the Glittre Activities of Daily Life tests) in terms of design and requirement for specific equipment limits their use to specialized teams. These tests should be conducted by physiotherapists or exercise specialists who are trained to administer exercise and functional tests in COPD. Pulmonary function and exercise laboratories, in which exercise testing procedures are often performed, may offer appropriate clinical settings for the administration of these functional tests.

Other functional tests such as the sit-to-stand test, the timed up and go test, and the 4-m gait speed test require minimal equipment and space and could be used in primary care settings. The specific context, the information sought through the measurement and patients' limitations and own objectives should all be considered when choosing a functional test over another. These issues are detailed in Part 2 of this seminar series, in which the main functional tests commonly used or recommended to assess upper and lower body functional capacity in patients with COPD and in laboratory settings are discussed, based on the knowledge of the constructs and validated properties of the tests. ■

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

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