

# The assessment of function: How is it measured? A clinical perspective

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Testing for outcome or performance can take many forms; including multiple iterations of self-reported measures of function (an assessment of the individual's perceived dysfunction) and/or clinical special tests (which are primarily assessments of impairments). Typically absent within these testing mechanisms is whether or not one can perform a specific task associated with function. The paper will operationally define function, discuss the construct of function within the disablement model, will overview the multi-dimensional nature of 'function' as a concept, will examine the current evidence for functional testing methods, and will propose a functional testing continuum. Limitations of functional performance testing will be discussed including recommendations for future research.

**Keywords:** Functional testing, International Classification of Functioning, Physical performance tests, Physical therapy

## Introduction

Through the assessment of changes in pain and movement, and corresponding improvements that arise from these changes, manual therapists routinely evaluate within the disablement process at the levels of impairment, functional limitation, and disability. Impairment has previously been defined as 'anatomical, physiological, mental or emotional abnormalities or loss', whereas functional limitation is defined as 'limitation in performance at the level of the whole organism or person'. In contrast, disability is considered a 'limitation in performance of society defined roles and tasks within a sociocultural and physical environment'<sup>1</sup> or more succinctly as 'any restriction or lack of ability to perform a task or an activity in the manner considered normal for a person'.<sup>2</sup> The disablement model refers to 'various impact(s) of chronic and acute conditions on the functioning of specific body systems, on basic human performance, and on people's functioning in necessary, usual, expected, and personally desired roles in society'.<sup>1,3,4</sup> Therefore, this model is used to determine the consequences of disease and injury 'both at the level of the person and at the level of society'.<sup>1</sup>

In contrast to disablement models such as the Nagi model,<sup>1</sup> the International Classification of Impairments, Disabilities, and Handicaps Disablement Model (ICF)<sup>2</sup> does not discriminate between functional limitation and disability. The domains described within the

ICF model are classified from body, individual, and societal perspectives by means of two lists: (1) a list of body functions and structure; and (2) a list of domains of activity and participation. Activity and participation are influenced by contextual factors, including personal and environmental. The ICF differs most dramatically from the disablement model in that the definition of functioning (or activity) is highly complex and multi-dimensional, and likely differs from person to person.

The purpose of this clinical perspective involves examination of the concept of function, how this concept can be assessed, as well as its suggested implementation and limitations in the current literature. Additionally, we propose an examination continuum, incorporating a more comprehensive functional testing system.

## Key Point #1: There are a Number of Current Measures of Functional Assessment

Function is measured in a number of different ways, including through the use of impairment measures, self-report measures, and physical performance measures (PPMs). The current measures of function all have unique contributions and dedicated limitations.

### *Impairment-based measures*

Impairments are defined as a dysfunction or a significant structural abnormality in a specific body part or system.<sup>4</sup> Findings of impaired joint mobility, motor function, muscle performance, range-of-motion (ROM), and sensation are considered problems that

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are limited to the impairment level.<sup>1</sup> These impairments, alone or in combination, can contribute to limited function and ultimately may have consequences for physical functioning.<sup>3</sup> For example, impaired humeral head inferior translation can contribute to the inability of a person to comb their hair due to mechanical shoulder impingement pain. Restricted ROM at the hip may lead to a limp during gait.

Clinical special tests are used to determine the tissue source of pain and are impairment-based assessments. It has been previously suggested<sup>5</sup> that clinical examination testing has demonstrated an over-reliance on these clinical special tests despite multiple psychometric and performance deficiencies.<sup>6-9</sup> The majority of stand-alone clinical tests do not demonstrate high levels of sensitivity and/or specificity,<sup>6-9</sup> thus questioning the validity of use. Additionally, several clinical practice guidelines state that the tissue source of many forms of musculoskeletal pain cannot be specified in the majority of patients.<sup>10-13</sup>

Lastly, a clinical examination finding of an impairment does not always correspond to a functional loss. Using the previous examples of restricted inferior glide and a limp originating from a lack of range of the hip helps represent the precarious relationship. Limited humeral head inferior glide may not always directly correlate with the actual concept of physical function (combing hair), as the patient may compensate by side-bending their head towards the involved extremity or through use of the opposite extremity. Poor ROM and a limp may be sub-threshold for patients whose activity levels are low, thus do not compromised the individual to the point where their expectations are altered.

### *Self-report measures*

Self-report measures are common methods of having the patient assess their pain and function. Self-report measures involve careful evaluation of instrument reliability, responsiveness, and validity and much work has been dedicated towards the development of these tools. Nearly all body regions or conditions have dedicated self-report functional measures that have been created.

Indeed, self-report measures are valuable in defining the patient's perspective of their change but have been shown to differ substantially from PPMs that involve quantification of output, and are dramatically influenced by changes in pain.<sup>14-21</sup> A reduction in pain after total joint arthroplasty has been associated with patients' self-reported improvements in their functional ability, even though their time to complete performance tasks had doubled.<sup>22</sup> In other words, patient's perception of their functional ability was inflated in instances of decreased pain for these patients.

The relationship between self-reports of pain level and function has frequently been investigated in patients with low back pain (LBP), demonstrating low to moderate levels of association between self-report measures of LBP and PPMs.<sup>15,23</sup> Patients systematically and significantly overestimate LBP at preferred and fastest speeds of movement with sit-to-stand tasks. There was also a trend towards underestimating expected pain at slow speeds of movement with the sit-to-stand tasks.<sup>24</sup> An additional concern of self-report measures is that these measures do not always differentiate between whether or why a specific task is not done or cannot be done.<sup>25</sup> Clearly, self-report measures are important, but should be utilized cautiously, and serve only as one component of the assessment of function.

### *PPMs*

PPMs have become increasingly popular methods of measuring specific characteristics of function, especially in post-injury assessment,<sup>15,26-37</sup> determining fall risks<sup>38-41</sup> and sports performance/injury prediction.<sup>42-44</sup> Although several authors<sup>45</sup> have described these tests as functional tests, a more accurate depiction of these testing methods is that they are measures of physical performance. While some of these tests have demonstrated causal relationships for both post-injury<sup>15,26-37</sup> and pre-injury risk assessments,<sup>38-44</sup> they are often just one test and measure just one parameter of function. Additionally, the depth of investigation into these relationships is lacking.

Of particular concern for the spine manual clinician is the dearth of investigation regarding trunk endurance/capacity with reference to function. While trunk endurance testing has been investigated in healthy individuals for normative values,<sup>46-50</sup> as well as post-surgical individuals with correlation to fear avoidance behavior,<sup>51</sup> its incorporation into function has not been investigated. Therefore, the value of such testing in patients with LBP is currently uncertain.

As previously mentioned, a limitation of PPMs is their use to predict successful return to function and prediction of future injury. Unfortunately, this is a limitation with all current testing means, and an unsettled area of investigation. Reasoning for limited evidence support in this realm is multiple. Different medical and performance enhancement disciplines examine different components of function. Some of these disciplines are rooted in anecdotal evidence as the highest form of substantiation. Other disciplines have just begun to investigate this type of testing. The type of testing that is truly necessary to verify these tests are long-term longitudinal, prospective, and retrospective studies.

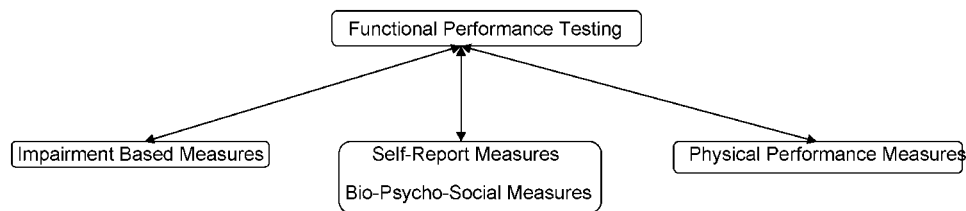


Figure 1 Conceptual model of comprehensive assessment of function.

**Key Point #2: There is a Need for Functional Performance Testing (FPT)**

Presently used methods of assessing function in clinical practice are incomplete. Much like the difficulty in, and complexity of, measuring function, there is the obstacle of defining function and the definitive assessment process for it.

*FPT defined*

‘Testing’ is defined as using a set of problems to assess abilities. Therefore, we have previously termed FPT to mean using a set of tests to determine performance abilities or functional limitations.<sup>45</sup> In other words, FPT is not impairment or PPM testing (Table 1). In simplified terms, impairments and PPM are typically more isolated findings while function is a more global concept incorporating the entire extremity, body, or person.

Pain perception and movement, both integral elements in assessment of manual therapy interventions, are mediated by contextual elements such as cognitive, emotional, and social factors.<sup>45</sup> Consequently, an expanded conceptual model of patient management and assessment at a functional, rather than impairment or PPM level, is necessary to fully evaluate all the elements associated with functioning.<sup>45</sup> This expanded conceptual model (FPT), ventures to capture the multiple dimensions of function through clustered physical performance movements.

FPT can therefore be more complexly defined as using a variety of physical skills and tests to determine: (1) one’s ability to participate at the desired level in sport, occupation, and recreation or to return to

participation in a safe and timely manner without functional limitations; and (2) one’s ability to move through up to three planes of movement as determined via non-traditional testing that provides qualitative and quantitative information related to specialized motions involved in sport, exercise, and occupations.<sup>45</sup> The clinician should understand that FPT is an aspect of everyday life, whether for the elite athlete, the industrial worker, or the homemaker. The commonality among all groups is that some aspect of performance is needed for each individual to be successful in performing their respective skills or duties.<sup>45</sup>

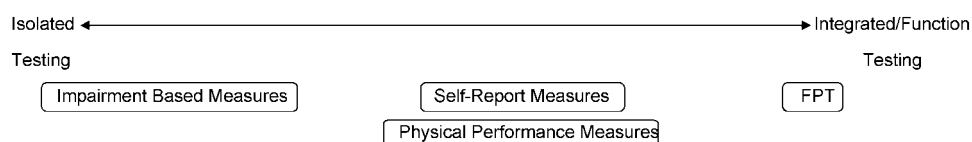
Compared to clinical assessment with special tests, assessments with FPTs test the ability of the person to put together a series of movements (rather than isolated single joint and planar movements) to safely and efficiently complete a task. In other words, assessment at the functional level assesses function of the person rather than function of the part of the person.<sup>24</sup> For example, the fact that a person has full hip, knee, and ankle ROM does not ensure successful return to basketball. If this same person has normal joint play, full strength, and full neuromuscular control and additionally is able to achieve an excellent score on jumping/hopping and anaerobic endurance tests without adverse symptoms, there should be much more confidence about the prospect of a safe return. Many FPTs closely approximate the activities that people need or wish to do.

We recommend the expansion of these recommendations to state that measurement of an individual’s ability to properly function should be along a continuum, and should include multiple measures (Figs. 1 and 2

Table 1 PPMs compared to isolated components of functional tests utilized in musculoskeletal testing

Impairment tests (isolated components)	PPMs (integrating components of impairment testing)
<ul style="list-style-type: none"> <li>• Muscle performance (primarily includes manual muscle testing)</li> <li>• Motor function</li> <li>• ROM (including muscle length)</li> <li>• Joint integrity and mobility</li> <li>• Sensory integrity</li> <li>• Reflex integrity</li> <li>• Posture</li> <li>• Pain</li> <li>• Peripheral nerve integrity</li> <li>• Gait, locomotion, and balance</li> <li>• Aerobic capacity/endurance</li> </ul>	<ul style="list-style-type: none"> <li>• Trunk endurance testing</li> <li>• Movement patterns</li> <li>• Excursion reach testing</li> <li>• Jumping tests</li> <li>• Hopping tests</li> <li>• Strength testing</li> <li>• Power testing</li> <li>• Aerobic endurance testing in multiple planes of movement</li> <li>• Lifting tests</li> <li>• Balance/proprioceptive testing in multiple planes of movement</li> <li>• Medicine ball throws</li> <li>• Softball throw for distance</li> <li>• Speed, agility, and quickness testing</li> </ul>

Note: PPMs=physical performance measures; ROM=range-of-motion.



**Figure 2** Proposed examination continuum. FPT=functional performance testing.

and Table 2). To achieve this objective, the measurement of function demands careful individual consideration and investigations of the interactions among various examination methods.

Traditional thought regarding the examination process might suggest that the normal assessment 'procedures' progress from self-report measures to examination (including observation) followed by special testing (with use of clinical measures or other tests). FPT, if employed, would then be implemented at the very end stage of the rehabilitation process. It is our contention that the measurement of function requires assessment of combinations of these measures (Fig. 1) throughout the rehabilitation process. Examination of a patient's function requires assessment of the entire disablement model.

The conceptual model illustrated in Fig. 1 suggests this comprehensive approach to measuring function. It should also be pointed out that this conceptual model advocates multi-directional flow along the assessment continuum. There are levels of function assessment (Table 2). Lower levels of function assessment can be implemented earlier in the examination process when warranted. In the above example, the use of functional movement and Rockport walk test could be utilized even prior to jumping/hopping and/or isokinetic testing in some dysfunctions. Functional movement could be utilized to screen for normal joint mobility in many early stage rehabilitation programs assuming safety. Additionally, the use of the deep squat assessment component of the Functional Movement Screen™ (Functional Movement Systems, Danville, VI, USA)<sup>43</sup> could be used to determine restricted mobility of the hip joint (impairment). Lack of sufficient hip mobility would not allow the patient to perform a proper deep squat. Performing this assessment early in the examination process would allow the clinician to complete the necessary impairment assessments in order to ascertain the reason(s) for improper deep squatting. Another example of multi-directional flow examination may have a patient perform the firefighting 'ability test'<sup>52</sup> (as long as not contraindicated), allowing the clinician to assess for potential restricted abilities, whether they exist at the PPM or impairment level. An unsuccessful attempt at a specific component of this test does not specifically uncover the limitation, but it can allow the clinician to converge on identifiable areas of interest (impaired joint mobility, decreased muscle performance, etc.). Use of higher levels of testing in this

fashion can prove beneficial in determining the limiting factors of function in these patients. The following articles in this series plan to use an algorithmic approach to demonstrate such examples of the integration of the multiple types of testing that we suggest in the comprehensive examination conceptual model. The combination of all of these testing approaches measures the concept of function.

### Key Point #3: Limitations of FPT and Future Directions in the Assessment of Function

Not unlike normal objective and clinical special tests for musculoskeletal dysfunction, FPT has limitations. Since it is our suggestion that FPT is a comprehensive compilation of various assessment methods (each with their own respective limitations), the limitations of this assessment method are ample. The same limitations described above for each respective domain of FPT are applicable.

Incorporating clusters of PPMs, or specific aspects of an individual patient's functional requirements, presumably more accurately indicates their current level of function. While these types of tests do exist, their worth is uncertain. Functional capacity evaluations are measurement tools created to assist in determining safe, tolerable levels of function and for predicting when an individual is ready to return to work duties.<sup>53</sup> Manual handling, including lifting and carrying, has been described as the primary determinant for rating a job's physical demands.<sup>54</sup> It has been argued though that lifting capacity may not have much to do with subsequent injury or even job success.<sup>55</sup> Additionally, the findings of spine ROM and muscle strength have little relationship with future LBP.<sup>47,56,57</sup> Trunk muscle endurance, on the other hand, has demonstrated some predictive value of future episodes of back pain, suggesting that the capacity to perform repetitive prolonged work may be more closely linked to muscle endurance and actual job demands.<sup>46,47</sup> Trunk endurance testing, as described above, is more likely an assessment of physical performance versus function as it does not mimic any movement of function in sport or the work place.

Other investigations have utilized more practical PPM's for LBP.<sup>15,23,58,59</sup> However, comparisons to normal individuals without LBP are lacking. Therefore, assessment of the most appropriate test(s) for the pre- and post-injury LBP patient, whether they are impairment, PPM's self-report measure, or some combination thereof, are overdue.

**Table 2 Proposed levels for assessment of function in an individual**

Levels for the assessment of function	Assessment examples
<p>Level I Assessment primarily at the level of subjective report (patient and clinician)</p>	<ul style="list-style-type: none"> <li>• Self-report measures most indicative of dysfunction</li> <li>• Bio-psycho-social measures relevant to dysfunction</li> <li>• Self-report of activity rating scales (patient interpretation on specific requirements of their necessary activity level to return to previous level of function)<sup>61</sup></li> <li>• Clinician analysis of specific sport/occupation/activities of daily living with respect to requirements (specific type of movements, energy system involvement, etc.)</li> </ul>
<p>Level II Assessment primarily at the level of impairment</p>	<ul style="list-style-type: none"> <li>• Anthropometric measurements (body mass index, girth and height measurements, etc.)</li> <li>• Muscle length</li> <li>• Manual muscle testing</li> <li>• ROM</li> <li>• Sensation</li> <li>• Joint play</li> </ul>
<p>Level III Assessment primarily at the level of static observation/posture/balance</p>	<ul style="list-style-type: none"> <li>• Static posture</li> <li>• Static balance (bilateral and single-leg balance static assessment)</li> </ul>
<p>Level IV Assessment primarily at the level of dynamic posture, general movement patterns, and single plane dynamic balance</p>	<ul style="list-style-type: none"> <li>• Dynamic posture (posture of individual as they perform movements required)</li> <li>• General movement patterns (walking, transfer movements, etc.)</li> <li>• Dynamic balance predominantly in one plane of movement without quality assessment (functional reach test, tandem walking, etc.)</li> </ul>
<p>Level V Assessment primarily at the level of movement patterns encountered during higher level tasks and/or multi-planar dynamic balance</p>	<ul style="list-style-type: none"> <li>• Assessment of movement patterns the individual performs with their primary tasks (specific sport, occupational, etc. tasks)</li> <li>• Four square step</li> </ul>
<p>Level VI Assessment primarily at the level of specific movement patterns</p>	<ul style="list-style-type: none"> <li>• Functional movement screen</li> <li>• Movement impairment syndrome assessment</li> </ul>
<p>Level VII Assessment of the individual primarily at the level of performance-based measures (PPM) occurring predominantly in one plane of movement</p>	<ul style="list-style-type: none"> <li>• 1 RM testing</li> <li>• Trunk endurance</li> <li>• Sit-up endurance</li> <li>• Supine bridge</li> <li>• Loaded forward reach</li> <li>• Lunge</li> <li>• Flexed arm hang</li> <li>• Step-down</li> <li>• Single-leg squat</li> <li>• Single-leg inclined squat on total gym</li> </ul>

**Table 2 Continued.**

Levels for the assessment of function	Assessment examples
<p>Level VIII                      Assessment primarily at the level of PPM occurring predominantly in one plane of movement, but requiring one or more of the following:</p> <ul style="list-style-type: none"> <li>• Limited base of support</li> <li>• Multiple joint involvement</li> <li>• Multiple muscle group involvement</li> <li>• Explosive movement</li> </ul>	<ul style="list-style-type: none"> <li>• Aerobic endurance testing</li> <li>• 1-mile walk</li> <li>• Rockport walk</li> <li>• 1.5-mile run</li> <li>• 12-minute run</li> <li>• 20-meter shuttle run</li> <li>• Wingate anaerobic power</li> <li>• Star excursion balance test</li> <li>• Knee bending in 30 seconds</li> <li>• Single jump and hop testing in one plane of movement</li> <li>• Standing long jump</li> <li>• Single-hop for distance</li> <li>• Vertical jump</li> <li>• Seated chest pass</li> <li>• Seated shot-put throw</li> </ul>
<p>Level IX                      Assessment primarily at the level of PPM occurring predominantly in multiple planes of movement and/or requiring explosive movement</p>	<ul style="list-style-type: none"> <li>• Jump and hop testing in multiple planes of movement or requiring multiple jumps or hops</li> <li>• Side-hop</li> <li>• One-legged cyclic hop</li> <li>• Hexagon jump</li> <li>• Modified hexagon hop</li> <li>• Figure 8 hop</li> <li>• Carioca drill</li> <li>• 6-meter timed hop</li> <li>• Triple jump for distance</li> <li>• Triple hop for distance</li> <li>• Single-leg crossover hop for distance</li> <li>• Hop testing after fatigue</li> <li>• 300 shuttle run</li> <li>• Bosco test</li> <li>• Running-based anaerobic sprint test</li> <li>• Lower extremity functional test</li> <li>• Speed and agility testing</li> <li>• Edgren side-step</li> <li>• Illinois agility</li> <li>• Pro agility (5-10-5)</li> <li>• Three-cone drill</li> <li>• T-test</li> <li>• Zigzag run</li> <li>• Sidarm medicine ball throw</li> <li>• Underkoffler softball throw for distance</li> </ul>

**Table 2 Continued.**

Levels for the assessment of function	Assessment examples
<p>Level X Assessment primarily at the level of PPM in multiple planes and/or explosive type of movement with the quality of the performance also assessed</p>	<ul style="list-style-type: none"> <li>• Balance error scoring system</li> <li>• Functional throwing performance index</li> <li>• Multiple single-leg hop stabilization</li> <li>• Tinetti assessment tool</li> </ul>
<p>Level XI Assessment primarily at the level of replication of the specific tasks performed during the individual's sport/occupation/daily activity and/or clustering of PPM that replicate component(s) of the sport/occupation/daily activity</p>	<ul style="list-style-type: none"> <li>• Functional capacity evaluation</li> <li>• Firefighting 'ability test'</li> <li>• BEAST<sub>90</sub></li> <li>• Functional abilities test</li> </ul>
<p>Level XII Cumulative assessment (FPT) including performance assessment (quantitative and qualitative) with self-report and bio-psycho-social measures</p>	<ul style="list-style-type: none"> <li>• Assessment forward and backward along the functional continuum (Fig. 2) utilizing each parameter of function (impairment, performance measures, and self-report measures) as necessary</li> </ul>

**Note:** ROM = range-of-motion; PPM = physical performance measure; 1RM = one repetition maximum BEAST<sub>90</sub> = ball-sport endurance and sprint test; FPT = functional performance testing.

Combining various examination methods for the purpose of evaluating function has recently been suggested with the use of the Delaware Osteoarthritis profile to include subjective and objective measures in post-surgical total knee arthroplasty patients.<sup>60</sup> Expansion of this model is suggested (Figs. 1 and 2 and Table 2) for all orthopedic and sports-related patients as it does not entirely encapsulate the convolution of function. Determining the most efficacious combination of these multiple measures will require diligent investigation.

A final suggestion regarding the future investigation of function and the use of FPT is to investigate the entire concept of function assessment as proposed to determine which combination of these assessments is most predictive of function success and future injury prediction. Deficiencies exist in each examination procedure of function outlined in Fig. 1. The psychological and social effects of a patient's function have increasingly warranted investigation. One potential suggestion for investigation is determining if the potential exists for clustering of FPT scores, similar to what is currently investigated with special testing, in order to define those athletes/patients at greater risk. Determining the relationship among these different variables is a complex task, one that will most likely require interaction among multiple disciplines.

**Conclusion**

Capturing a patient's capabilities is a complex undertaking. Integrating current testing methods into an assessment continuum will provide the best determination of the patient's current status. The use of various forms of testing is necessary to ascertain the patient's abilities. The use of these various tests should be on a continuum that allows for movement in all directions. Limiting our examination process to self-report measures and assessment of specific impairments is not conclusive. FPT provides the best medium to mimic the patient's actual functional activity. As with each form of examination, FPT is not without its limitations. Increased emphasis on research with necessary long-term studies is required to determine its best applicability. Despite its limitations, FPT is the best 'big picture' testing mechanism that we have.

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