Functional Capacity Evaluation and Chiropractic Case Management

Purpose: In an era when expensive tests have flourished, it is timely that efficient and economical functional tests satisfying fundamental criteria are developed in order to contain costs. An overview of functional capacity tests is provided, and a discussion of types and components is offered. Further, the validity of functional tests is addressed, especially their ability to predict either an individual's performance in a target task or the development of future back pain/disability. **Method:** A qualitative review of relative literature is integrated with the clinical experience of the authors. **Summary:** Functional capacity tests are designed for use when a patient has been in treatment for 1 month and care may extend beyond a reasonable expected natural history. Functional capacity testing provides baseline information from which objective improvement can be monitored. It can also help in establishing a rehabilitation prescription, determining return to work goals, and determining an end point of care. **Key words:** *accidents (occupational)*, *activities of daily living*, *disability evaluation*, *pain measurement*, *questionnaires*, *range of motion (articular)*, *rehabilitation*, *work capacity evaluation*

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Practice aids and algorithms appear in Appendix A.

FUNCTIONAL TESTING is a key part of the outcomes management process. According to a recent North American Spine Society consensus paper, a functional capacity evaluation (FCE) assesses whole body limitations such as lifting capacity and cardiovascular fitness.[1] Many of the most important functional capacities relate to tasks, activities, or roles that the individual is expected to carry out in his or her occupation or lifestyle. Any limitation or inability to perform tasks or activities is typically termed a "disability."

The FCE is contrasted with the physical capacity evaluation (PCE), where physical performance tests address discrete functional limitations such as trunk strength and mobility.[1] An example of a PCE is the Quantitative Functional Capacity Evaluation (QFCE), which is presented by the authors elsewhere.[2] The deficits that a PCE or a QFCE measures are considered to be "impairments" or functional limitations. Impairments, functional limitations, and disability are part of a continuum from pathophysiology to a societal limitation.[3]

Functional testing is an extension of simple outcomes assessment (OA) with questionnaires and/or specific functional measurements (i.e. straight leg raise test, spine range of motion, etc.). It is necessary to perform such evaluations after the first month of care if treatment is expected to continue beyond 6 to 8 weeks, which is the usual recovery point in the natural history of nonspecific "mechanical" back pain. The true importance of these tests is that they document whether

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Table 1. Fundamental criteria regarding any functional test

- Safety
- Reliability
- Cost-effective/time efficient
- Normative database
- Validity

Source: Mooney V, Matheson LN. *Objective Measurement of Soft Tissue Injury: Feasibility Study; Examiner's Manual.* Whittier, CA: Los Angeles College of Chiropractic; 1994.

or not the care provided is useful. This may be important for personal injury, worker's compensation, private insurance, or managed care patients.

A fundamental indication for an FCE, is when the patient cannot work and the disability has been present for longer than 1 month (total disability). However, if the patient is not totally disabled, but does have activity limitations and/or symptoms for greater than 1 month (partially disabled), then the less costly and less time consuming QFCE or PCE may be more appropriate.

The functional tests selected should satisfy certain fundamental criteria (Table 1). A test that has been determined to be reliable may be useful to document an individual's progress. Tests that have a normative database can identify what percentage of normal function exists at baseline and, therefore, can guide the provider in establishing a specific functional restoration exercise program. This feature will also allow the provider to set specific rehabilitation goals accurately so that realistic end points of care can be prospectively determined.

As previously stated, specific functional limitations evaluated by PCEs are considered impairments, while whole body movement evaluations such as the FCE determine levels of disabilities. An "ideal" valid test relates not only to impairment, but also to disability, and, therefore, relates to specific tasks or skills. This type of valid test yields practical clinical information. However, providing this type of information is perhaps the most challenging criterion to satisfy.

A beginning point for evaluating functional status, impairment, or disability is determining the work or activity limitations of an individual. According to Agency for Health Care Policy and Research (AHCPR) guidelines,[5] reduction of activity intolerance is the main goal of care in addition to pain relief. Mooney and Matheson's Job Demands Questionnaire (JDQ) and Job Sort (JS) are practical starting points because they identify the specific *Dictionary of Occupational Titles* (DOT) items such as standing, walking, sitting, lifting, etc, which may be relevant for an injured worker.[3] A copy of the JDQ is provided in Appendix A1. In addition, outcomes assessment questionnaires like the Oswestry low back pain disability questionnaire[6] or the neck disability index (NDI),[7] can also be used to identify specific activity limitations that have occurred. The more specific the determination of activity limitation or job demands, the easier it will be to establish mutually agreeable goals and end points of care. Use of the JDQ and JS is therefore key to determining the specific functional tests needed to evaluate the patient who is disabled or impaired and hence will also function in establishing rehabilitation protocols that are individualized to the patient.

Specific functional tests with proven reliability and normative databases, which relate to a job demand or activity limitation can be used to establish an individual's functional capacity. When returning a worker who was injured back into the work force, it is equally important to establish the functional limits of a job site so that the worker is not placed in a job that exceeds his or her functional capacities. According to Fishbain and coworkers,[8] DOT defines the *demand minimum functional capacity* of most jobs in the United States. By using the data derived from a patient's FCE or PCE and comparing it to a job's demand minimum functional capacity, the likelihood of reinjury is lessened. In this era of health care cost containment, comparing the activity limitations of a patient on the one hand, and the job demands on the other, the cost-effectiveness of an FCE or PCE is highly defensible.

CLINICAL INTEGRATION OF FUNCTIONAL TESTING

There are five steps involved in integrating an FCE or PCE into a chiropractic practice model (Table 2). First, is performing a JS or JDQ (or both) to identify the activities that are important for that individual. Second, is taking a history of activity limitations (see Appendix A2). Third, is determining the patient's residual functional capacities with respect to the

Table 2. Steps to integrate functional testing into the chiropractic practice model

Step	Description
1	Perform Job Demands Questionnaire and/or Job Sort
2	Obtain history of activity limitations
3	Determine the patient's residual functional capacities and compare with the demand minimum functional capacity of the job
4	Communicate to the patient, third-party payer, and employer the specific goals of care with respect to activity and functional limitations in order to return the patient safely and promptly back to work
5	Devise functional restoration prescription that specifically addresses the patient's functional limitations and job demands

tasks that are important for that individual and comparing those with the demand minimum functional capacity of his or her job or specific work task. Fourth, is communicating to the patient, employer, and third-party payer the specific goals of care with respect to activity and functional limitations that relate to the job description and to compare them to the available worksite demands. Fifth, is forming a prescription for functional restoration that specifically addresses the patient's functional limitations and job demands.

The evaluating physician must identify what activities or job demands are relevant for the patient. The JDQ is a short questionnaire that identifies how demanding the patient perceives his or her job to be. It can be self-administered and it is a very brief way (8 to 10 minute) to identify what kind of demands for lifting, carrying, sitting, and so forth are placed on the individual. Mooney and Matheson's JS is a set of small cards that show a wide variety of job tasks. The patient is instructed to pick out those cards that most closely resemble the tasks he or she performs on the job or at home. This methodology enables the physician to determine the patient's work activities as well as the patient's perception of his or her job demands.

The second step is to take the history directly from the patient. The practitioner should seek to identify what activities are limited by the patient's pain. Most important, the practitioner should determine limitations in basic activities such as sitting, standing or walking (see Appendix A2). The Oswestry low back pain disability questionnaire[6] or NDI[7] can also be used to identify limitations of other activities of daily living (ADL). Patients should be asked what activities they are unable to perform due to pain.

The third step in this process is the actual functional testing (FCE or PCE). A true FCE includes whole body testing including the following[8]:

- lifting capacity,
- hand function tests,
- daily living activity tests (i.e. pushing, pulling, carrying, kneeling, squatting),
- cardiovascular testing,
- upper body ergonometry, and
- static positional tolerance tests.

Most FCEs take 2 or more hours to perform, while some require up to 2 days and use expensive equipment. However, a PCE, such as the QFCE[2], has the potential to be as valid as an FCE but requires far less time and expense. It gives special emphasis to simple, time-efficient, cost-effective functional testing and takes only 30 to 35 minutes to be administered. Thus, even though the QFCE does not measure lifting/carrying directly, the savings in time and resources are significant enough that this approach has great practical value.

Often, only those tests that relate to the specific activity limitation or job demand need be assessed when concerned primarily with return-to-work goals. All of those activities which are relevant should be assessed to see if the patient can achieve the functional capacity to meet the demand minimum functional capacity of the job.

The validity of the QFCE for determining work capacity is somewhat compromised because many whole body activities are not directly tested. However, functional movements which do correlate with the whole body activity can be compared. For example, in a classic FCE, lifting capacity requires time-consuming (PILE, EPIC) or expensive (Cybex) testing. A more cost- and time-efficient approach for rehabilitation specialists is to test squatting strength, back extensor endurance, hamstring flexibility, and static positional tolerance. For example, quadriceps strength was found to be a limiting factor in a study group of forestry workers who shifted from a squat lift to a stoop lift when quadriceps weakness was present[9]. Back extensor endurance is necessary to preserve the lumbar lordosis during lifting. Hamstring (and thigh adductor) flexibility is also crucial for allowing the back to remain upright and lordotic during squatting.

The fourth step in integrating functional tests with clinical practice is communication of functional goals and capacities. The history of activity limitations automatically identifies end points or goals of care. According to the AHCPR guidelines,[5] the primary goal of care of low back pain is to reduce activity limitations. These activity limitations can be clearly communicated to the patient, employer, and third-party payer after they are determined. Also, the functional restoration of any functional capacity deficit becomes a realistic end point of care.

The fifth and final step in this process is prescribing functional restoration for the physical and functional capacity deficits disclosed by testing. A typical example is a patient who, for example, cannot bend or stoop and has functional deficits such as poor trunk extension endurance and mobility. The functional restoration prescription may involve manipulation, exercise and advice. More specifically, manipulation to restore joint range of motion involved in lumbar extension; exercises to address strengthening of the erector spinae musculature including endurance training for spinal erectors, multifidus, and gluteus maximus muscles; and, advice about avoiding slumping during ADL may also prove beneficial.

THE VALIDITY OF THE QFCE AND COMPARISON TO THE DOT

Functional tests that correlate to real life activities have the most validity. The performance of valid tests (from both a qualitative and quantitative standpoint), yields information that can be practically applied to the care of a patient; the test therefore has prescriptive validity. The "ideal" test is one that has proven reliability in the methods, validity in its application, and a normative database. Such a test can provide a

baseline for future comparative assessment In this way, the specific rehabilitation approach can he assessed for effectiveness. In addition, the point of maximum therapeutic benefit with passive and/or active care can he identified when no change in function is observed. This important step can then assist the health care provider to

- Change the rehabilitation or treatment protocol.
- Refer the patient to the next "level" of service (to a secondary or tertiary care center).
- Accept the current level of function as permanent

When considering the return of the patient to work. an ideal functional test is one that utilizes real life movements. For example, if squatting is a significant task of a patient's job and it is hindered by an injury, by utilizing the repetitive squat test and the normative data included in the QFCE. one can assess the patient's squatting capacity. One can then compare the patient's squatting physical capacity to the job's demand minimum functional capacity and a prescription for return to work squatting limitations could be determined. Hence, the DOT was developed and has been adopted as a standard for describing the physical demands of a specific job task, which are referred to as job factors.[11–13] There are 20 job factors described by the DOT including standing, walking, sitting, lifting, carrying, pushing, pulling, climbing, balancing, stooping, kneeling, crouching, crawling, reaching, handling (seizing, holding, grasping, turning), fingering (picking, pinching), feeling (size. shape, temperature, texture), talking, hearing, and seeing (acuity, depth perception, field vision, accommodation, color vision).

The DOT attempts to define most jobs in the United States according to these job factors and recommends that a worker possess at least the equivalent of the physical demands of the job task. Hence, the phrase demand minimum functional capacity (DMFC) describes the minimum functional capacity needed to work successfully and safely at a particular job.

Attempts have been made to assess a worker's physical performance on the job within the context of the DOT in quest of safely returning a worker who was injured hack to work. For example, Mooney and Matheson's[4] standing range of motion tests are static position tolerance tests that measure a person's ability to reach to various heights from standing, stooping, crouching, and kneeling positions. In this evaluation, the range of motion tests are described as an anthropometric examination, where the evaluee's own stature is used as a frame of reference. The test begins with an explanation of the purpose of each test using narrative similar to the following:

This is a test of your ability to reach with both hands to various heights while standing, stooping, crouching, and kneeling. You will be asked to maintain each of these postures for 15 seconds. If you have any symptoms during the test, please let me know. Do you have any questions?

The test is administered in front of a wall with the arms outstretched in front, feet shoulder width apart, and placed directly under the shoulders (ie, to avoid leaning). The preceding instructions are given and the test commences with an affirmative response of readiness by the evaluee. Instructions are given to the patient to move from a standing posture to each position listed subsequently and then back to a standing position:

Height (reach)	Posture
Shoulder level	Stand
Eye level	Stand
Knee level	Stoop
Knee level	Crouch
Knee level	Kneel

A maximum of a 1-minute standing rest between postures may be utilized. For each of the five postures, a countdown from 15 seconds is used. The following scale is used to rate the evaluee's performance:

Definition	Score
1. Able	Able to perform the task with no restrictions.
2. Slightly restricted	Able to perform the task with slight restrictions. Can hold the hands at the designated level for 15 seconds.
3. Moderately restricted	Able to assume the proper position; but is unable to maintain the position for 15 seconds.
4. Very restricted	Able to assume the position, but unable to hold the position for more than 5 seconds.
5. Unable	Unable to assume the position.

The test may be documented in the patient's file in the following manner:

	Able		Restricted		Unable
Can reach to					
Shoulder (height)	1	2	3	4	5
Eye	1	2	3	4	5
Knee-stoop	1	2	3	4	5
Knee-crouch	1	2	3	4	5
Knee-kneel	1	2	3	4	5

This information may help identify specific job traits and can play an important role in the detection of injury causation. It should he used before further DOT testing to identify which items require the most in-depth evaluation.

The next major hurdle is to devise a means by which the 20 DOT job factors can be clinically evaluated, fulfilling as many of the five criteria outlined earlier as possible (see Table 1). This effort may be partially accomplished by the establishment of functional capacity "norms" where the person who

was injured could be compared to a normative database and, after the initial baseline evaluation, had the evaluation repeated. The results could then be used to decide whether the person had reached the demand minimum functional capacity for his or her particular job or a lighter duty job task.

Because the DOT defines only two strength job factors (lifting and carrying) (see Table 3), jobs that demand other functional movements are not specifically assessed by this approach.

Fishbain and associates[13] offer functional tests with referenced normative data. When published normative data were not found, "clinical experience and acumen" were used to establish a "consensus opinion" among the authors. The authors represented numerous different professions including psychology, neurosurgery, and industrial engineering. A total of 17 job factors were used to make up the DOT-residual functional capacity (DOT-RFC) battery and, when including the subfactors, a total of 36 factors were measured for a total time duration of 3 hours and 16 minutes. A summary of the 17 job factors, the tests used to evaluate each, the time for each test, the procedure, response variable, defined norms, acceptable values, and reference to norms are listed in Table 4. Though recognized as less than perfect,[8,10,13,14] using the DOT criteria allows for a classification of patients for which the objective is the safe and timely return of a patient to work.

The following information correlates the QFCE,[2] sample Fishbain/FCE test,[13] and Mooney and Matheson's static positional tolerance tests[4] with DOT basic job traits.[11–12] In addition, qualitative testing is described to supplement the following tests when applicable.

Standing

- *QFCE tests:* Test time: 5 minutes. In order to maintain an upright standing posture, the activities of several muscle groups must be posturally active. The QFCE tests that assess these various muscle groups include the ankle dorsiflexion tests (gastrocnemius and soleus length tests), modified Thomas/hip extension test (iliopsoas length test), knee flexion test (quadriceps length test), repetitive arch-up, and static back endurance (lumbar extension muscle strength).
- *Static positional tolerance test:* To test endurance, have the patient stand for a given time frame such as 15 to 30 minutes.[4]
- *FCE test:* Test: Standing; Time (minutes): 30; Response variable: Tolerance; Defined norm: 30 minutes; Acceptable value: 30 minutes.[13]

Walking

- *QFCE tests:* Because this function is a multimuscular functional test, the same tests described under standing would apply, in addition to hamstring length (straight leg raise [SLR] test) and hip range of motion tests. The endurance aspect of walking can only be assessed by performing a more lengthy test such as walking at a given pace for 15 or 30 minutes.
- *Static positional tolerance test:* This test is not applicable.
- *FCE test:* Test: Normal walking; Time (minutes): 30; Response variable: Average walking speed (1 mile); Defined norm: 3 miles per hour, 1 mile; Acceptable value: 2 miles per hour, 1 mile.13-15
- *Qualitative test:* The one-leg standing testing is also appropriate. Employing a timed test adds a quantitative complement to this test. Normative data report that, with the eyes open, those aged 20 to 59 balanced on one leg for 29 to 30 seconds; 22.5 seconds for those aged 60 to 69 years; and 14.2 seconds for those aged 70 to 79 years. With the eyes closed, those aged 20 to 59 years balanced on one leg for 21 to 28.8 seconds; 10 seconds for those aged 60 to 69 years and 4.3 seconds for those aged 70 to 79 years.[16]

Sitting

- *QFCE tests:* The primary muscles involved are those of trunk stabilization in which the static back endurance repetitive arch-up, and repetitive sit-up tests are utilized. The flexibility of the hamstrings, as well as the integrity

Table 3. Maximum lift and maximum carry definitions

Abbreviation	Term	Maximum lifting (lbs)	Maximum carrying (lbs)
S	Sedentary	10	5
L	Light	20	10
M	Medium	50	25
H	Heavy	100	50
V	Very heavy	100+	50+

Source: US Department of Labor, Employment and Training Administration. *Dictionary of Occupational Titles.* 4th ed. Washington, DC: Government Printing Office; 1986.

Table 4. DOT-RFC Test Description and Norms

DOT job factor	Test	Time (min)	Response variable	Defined norm	Acceptable value	Reference for norm
Standing	Standing	30	Tolerance	30 min	30 min	*
Walking	Normal walking	30	Avg. walking speed (1 mile)	3 MPH 1 mile	2 MPH 1 mile	15
Sitting	Sitting	30	Tolerance	30 min	30 min	*
Lifting	Iso-inertial	15	Max. acceptable wt raised and lowered	S = 10 lbs L = 20 lbs M = 50 lbs H = 100 lbs VH > 100 lbs	Same	DOT 11, 12
Carrying	Iso-inertial	15	Max. acceptable wt carried 14 ft.	S = 5 lbs L = 10 lbs M = 25 lbs H = 50 lbs VH > 50 lbs	Same	DOT 11, 12
Pushing	Iso-inertial	10	Walking pushing a cart 25'	100 lbs	> 100 lbs	15
Pulling	Iso-inertial	10	Moving pulling a cart 25'	100 lbs	> 80 lbs	15
Climbing	Stairs	5	1 flight up and 1 flight down	1 flight up 1 flight down	Same	*
Balancing on narrow surface	Standing Walking Crouching	3	Standing, walking, crouching, Length of beam 6 ft.	Able Able Able	Same Same Same	17
Stooping	Trunk flexion	3	Range of motion	> 75 deg	> 75 deg	*
Kneeling	Kneeling on 1 and 2 knees	3	Kneeling on 1 and 2 knees	Able Able	Same Same	17
Crouching	Pt. stoops > 75° and bend knees	3	Crouching	Able	Same	17
Crawling	Crawling hand/knee & hand/feet	3	6' each test	Able Able	Same Same	17
Reaching	Standing reach	3	Reaching any direction	Able	Same	17
Handing	Seizing Holding Grasping Turning	3 3 3 3	Seizing each hand & both hands Holding Turning	Able Able Able Able	Same Same Same Same	17
Fingering	Picking	3	Picking a nut with all fingers	Able	Same	
	Pinching	3	Tip pinching	M > 8 lbs F > 4 lbs	Same	19 20
			Key pinching	M > 9 lbs F > 7 lbs	Same	21
			Palmer pinching	M > 9 lbs F > 6 lbs	Same	
Feeilng	Shapes: Round Rectangle	5	Discrimination	Able	Same	
	Sizes: Large Small	5		Able	Same	17
	Temperature: Hot Cold	5		Able	Same	
	Texture: Rough Smooth			Able	Same	

*Committee norm. *Source:* Reprinted with permission from Fishbain DA, Abdel-Moty E, Cutler R, et al. Measuring residual functional capacity in chronic low back pain patients based on the dictionary of occupational titles. *Spine.* 1994;19:872–880. © Lippincott-Raven.

of the hip joint, must also be intact in order to sit. Hence, the SLR test is appropriate. The act of changing positions from sitting to standing or vice versa incorporates the actions of almost all the tests with the exception of cervical range of motion and grip strength.

- *Static positional tolerance test:* The issue of endurance of sitting can only be addressed by having a patient sit for a unit of time (eg, 30 minutes).[4]
- *FCE test:* Test: Sitting; Time (minutes): 30; Response variable: Tolerance; Defined norm: 30 minutes; Acceptable value: 30 minutes.[13]

Lifting

- *QFCE tests:* Classically, lifting is measured by floor-to-knuckle, knuckle-to-shoulder, and floor-to-shoulder lift tasks. The QFCE does not specifically assess lift capacity. Rather, all of the QFCE tests are needed in order to test bending, stooping, and squatting, which are components of lifting with the exception of cervical range of motion and repetitive sit-up with emphasis of back extensor strength (repetitive arch-up and static back endurance tests).
- *Static positional tolerance test:* This test is not applicable.
- *FCE test:* Test: Iso-inertial; Time (minutes): 15; Response variable: Maximum acceptable weight raised and lowered; Defined norm: Sedentary = 10 lbs, Light = 20 lbs, Medium = 50 lbs, Heavy = 100 lbs, Very heavy > 100 lbs; Acceptable value: Same.[11–13]

Carrying

- *QFCE tests:* These tests are not applicable.
- *Static positional tolerance test:* This test is not applicable.
- *FCE test:* Test: Iso-inertial; Time (minutes): 15; Response variable: Maximum acceptable weight carried 14 feet; Defined norm: Sedentary = 5 lbs, Light = 10 lbs. Medium = 25 lbs, Heavy = 50 lbs, Very Heavy > 50 lbs; Acceptable value: Same.[11–13]

Pushing

- *QFCE tests:* These tests are not applicable.
- *Static positional tolerance test:* This test is not applicable.
- *FCE test:* Test: Iso-inertial; Time (minutes): 10; Response variable: Walking pushing a cart 25 feet; Defined norm: 100 lbs; Acceptable value: > 100 lbs.[13,15]

Pulling

- *QFCE tests:* These tests are not applicable.
- *Static positional tolerance test:* This test is not applicable.
- *FCE test:* Test: Iso-inertial; Time (minutes): 10; Response variable: Moving pulling a cart 25 feet; Defined norm: 100 lbs; Acceptable value: > 80 lbs.[13,15]

Climbing

- *QFCE tests:* Requires repetitive squat, gastrocnemius and soleus, modified Thomas or hip extension, SLR, knee flexion, and hip range of motion (ROM) tests.
- *Static positional tolerance test:* This test is not applicable.
- *FCE test:* Test: Stairs; Time (minutes): 5; Response variable: One flight up and down; Defined norm: One flight up; Acceptable value: Same.[13]
- *Qualitative test:* The one-leg standing testing is also appropriate. Employing a timed test adds a quantitative complement to this test. Normative data report that, with the eyes open, those aged 20 to 59 years balanced on one leg for 29 to 30 seconds; 22.5 seconds for those aged 60 to 69 years; and 14.2 seconds for those aged 70 to 79 years. With the eyes closed, those aged 20 to 59 years balanced on one leg for 21 to 28.8 seconds; 10 seconds for those aged 60 to 69 years, and 4.3 seconds for those aged 70 to 79 years.[16]

Balancing

- *QFCE tests:* In this test, trunk stability is of great importance. Thus, all functions that are listed in the QFCE are required with the exception of the grip strength test.
- *Static positional tolerance test:* All of the standing range of motion tests, which include reaching from standing, stooping, crouching, and kneeling positions, are indicated regarding balance assessment.[4]
- *FCE test:* Test: Standing; Time (minutes): 3; Response variable: Standing, walking, crouching. Length of beam 6 feet; Defined norm: Able; Acceptable value: Same.[13,17]
- *Qualitative test:* The one-leg standing testing is also appropriate. Employing a timed test adds a quantitative complement to this test. Normative data report that, with the eyes open, those aged 20 to 59 years balanced on one leg for 29 to 30 seconds; 22.5 seconds for those aged 60 to 69 years, and 14.2 seconds for those aged 70 to 79 years. With the eyes closed, those aged 20 to 59 years balanced on one leg for 21 to 28.8 seconds; 10 seconds for those aged 60 to 69 years, and 4.3 seconds for those aged 70 to 79 years.[16]

Stooping

- *QFCE tests:* As noted under lifting, this complex movement requires function measured by all of the QFCE tests with the exception of cervical range of motion (C-ROM) and grip strength.
- Static positional tolerance test: The stooping portion of the standing range of motion tests is indicated.[4]

- *FCE test:* Test: Trunk flexion; Time (minutes): 3; Response variable: Range of motion; Defined norm: >75°; Acceptable value: Same.[13]

Kneeling

- *QFCE tests:* Repetitive squat, gastrocnemius and soleus, modified Thomas/hip extension, SLR, knee flexion, and hip ROM tests.
- *Static positional tolerance test:* The kneeling portion of the standing range of motion tests is indicated.[4]
- *FCE test:* Test: Kneeling on one and two knees; Time (minutes): 3; Response variable: Kneeling on one and two knees; Defined norm: Able; Acceptable value: Same.[13, 17]

Crouching

- *QFCE tests:* Repetitive squat, lumbar ROM (L-ROM), C-ROM, modified Thomas, SLR, hip ROM, repetitive arch-up, and static back endurance tests are indicated.
- *Static positional tolerance test:* The crouching portion of the standing range of motion test is indicated.[4]
- *FCE test:* Test: Patient stoops > 75° and bends knees; Time (minutes): 3; Response variable: Crouching; Defined norm: Able; Acceptable value: Same.[13, 17]

Crawling

- *QFCE tests:* Modified Thomas, SLR, knee flexion, and hip ROM tests are indicated.
- *Static positional tolerance test:* This test is not applicable.
- *FCE test:* Test: Crawling hand/knee and hand/feet; Time (minutes): 3; Response variable: 6 feet each test; Defined norm: Able; Acceptable value: Same.[13, 17]

Reaching

- *QFCE tests:* L-ROM (if tested in positions listed below in the static positional tolerance tests) is indicated.
- *Static positional tolerance test:* The standing range of motion tests, which include reaching from standing, stooping, crouching and kneeling positions, are indicated.[4]
- *FCE test:* Test: Standing reach; Time (minutes): 3; Response variable: Reaching any direction; Defined norm: Able; Acceptable value: Same.[13, 15]
- *Qualitative test:* The shoulder abduction test is performed by having the patient flex the elbows 90° (to limit undesirable rotation) and slowly abduct the upper extremities. A "+" test or failed qualification score is reported when scapula elevation or rotation occurs in the first 30° to 60°. The purpose of the test is to identify abnormal glenohumeral rhythm due to overactivity of the upper trapezius and/or levator scapulae muscles.[18] Quantification of this test by the use of an inclinometer or goniometer recording the measurement at the point of premature upper trapezius contraction is recommended.

Handling

- *QFCE tests:* Grip and pinch strength tests are indicated.
- *Static positional tolerance test:* This test is not applicable.
- *FCE test:* Test: Seizing, holding, grasping, turning; Time (minutes): 3 minutes each; Response variable: Seizing each hand and both hands, holding, turning, respectively; Defined norm: Able; Acceptable value: Same.[13, 15]

Fingering

- *QFCE tests:* Grip strength and pinch strength tests are indicated.
- *Static positional tolerance test:* This test is not applicable.
- *FCE test:* Test: Picking, pinching; Time (minutes): 3 minutes each; Response variable: (a) Picking a nut with all fingers, (b) Tip pinching, (c) Key pinching, (d) Palmer pinching; Defined norm: (a) Able, (b) M (males) > 8 lbs and F (females) > 4 lbs, (c) M > 9 lbs and F > 7 lbs, (d) M > 9 lbs and F > 6 lbs; Acceptable value: Same.[13, 19–21]

Feeling

- *QFCE tests:* These tests are not applicable.
- *Static positional tolerance test:* This test is not applicable.
- *FCE test:* Test: Shapes: Round, Rectangle; Sizes: Large, Small; Temperature: Hot, cold; Texture: Rough, smooth; Time (minutes): 5 minutes each; Response variable: Discrimination; Defined norm: Able; Acceptable value: Same.[13, 17]

Table 5 lists the 20 DOT job traits and the corresponding QFCE tests. Even though the QFCE tests are quantitative and hence, good for assessing outcomes, it is important to stress that assessment of the quality of movement is required in determining the safety in performing the job trait. Smith[22] reported inter-rater and intra-rater reliability in determining safe maximum floor-to-waist lifting for patients with low back pain during a FCE. In this study, 21 patients were videotaped lifting weight in progressively increased increments and observed by five experienced physical therapists. The study revealed that as weights increased and body mechanics deteriorated, the therapists could reliably determine when the biomechanical end point was near or reached.

The step where functional tests performed in a clinical setting are utilized to determine return to work issues is very important. The transition between functional test and work task performance has been addressed, and reliability appears to be present.[8, 10, 22] The challenge of returning the worker to a

Table 5. Correlation of *Dictionary of Occupational Titles* (DOT) job trait tests and Quantitative Functional Capacity Evaluation (QFCE) tests

QFCE→ / DOT↓	Repetitive squat	L-ROM	Gastro-cnemius	Soleus	C-ROM	Modified Thomas	SLR	Repetitive sit-up	Knee flexion	Repetitive arch-up	Hip-ROM	Static back endurance	Grip strength
Standing			Y	Y		Y			Y	Y		Y	
Walking			Y	Y		Y	Y		Y	Y	Y	Y	
Sitting							Y	Y		Y	Y	Y	
Lifting	Y	Y	Y	Y		Y	Y		Y	Y	Y	Y	Y
Carrying	NA												
Pushing	NA												
Pulling	NA												
Climbing	Y		Y	Y		Y	Y		Y		Y		
Balancing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Stooping	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	
Kneeling	Y		Y	Y		Y	Y		Y		Y		
Crouching	Y	Y			Y	Y	Y			Y	Y	Y	
Crawling						Y	Y		Y		Y		
Reaching		Y											
Handling													Y
Fingering													Y
The following DOT tests are evaluated by standard neurologic examination tests:													
Feeling													
Talking													
Hearing													
Seeing													

L=ROM, lumbar range of motion; C=ROM, cervical range of motion; SLR, straight leg raise; Hip=ROM, hip range of motion; NA, not applicable; Y, yes.

safe work environment prior to completion of healing has long plagued health care providers and employers as, so often, the worker returns to work and is reinjured. This problem may be due to an overestimation of patient function on the part of the physician, poor job selection by the employer, and/or inadequate reporting by the worker to the supervisor that the assigned job task is aggravating his or her condition. In addition, it has been observed that patient motivation, psychological stressors both inside (internal factors) and outside (external factors) the workplace, and employer/patient compliance with carrying out the job restrictions further complicate the return to work process.[8, 9, 14, 23]

In order for DOT information to be useful in returning the patient to work, the tests that evaluate function must be reliable and the patient must exert full effort. In addition, the demand minimum functional capacity must be calculated for each jobsite in order for the return to work form to be useful. If the minimums of a jobsite are not established, there is no baseline with which to compare the patient's functional capacities, and reinjury may more readily occur. The employer's role is to establish these minimums; the health care provider's role is to assess the patient in a manner by which the return-to-work criteria can be compared. The challenge of returning the patient to work safely has been addressed by a number of approaches, including the work of Mooney and Matheson, Fishbain, Lechner, Moffroid and associates, and Smith.[4, 8, 10, 13, 22, 23]

All attempts at reproducing conditions in the workplace will fall short of the mark. Replicating the work environment and all the associated stressors cannot be accomplished outside the workplace. Also, cumulative trauma effects cannot be reproduced in a short time duration. More specifically, many occupational injuries are caused by a series of events that occur over time (ie, cumulative trauma disorders). Hence, it is unlikely that a laboratory, clinic, or job simulator can reproduce an environment in which there are similar gradual stresses. In additional, factors of utility, practicality, and safety would be compromised if an FCE lasted 8 hours a day, 5 days a week, for 1 or more weeks. Therefore, when a high percentage of workers are injured in a particular job site, a workstation evaluation may be of greater benefit than focusing on the individual worker who was injured. In general, it has been reported that it is easier to change a worksite than to change a worker.[24]

CONCLUSION

A set of tests can quantify functional limitations or impairments.[2] Such tests are time efficient, simple and economical to perform. However, a true FCE measures actual whole body functions such as the DOT items and not isolated functional limitations. Unfortunately, these FCEs are typically time consuming and costly. Recognizing the need for an intermediate form of functional testing, the QFCE was developed. More specifically, the FCE is indicated for individuals with total work disability of greater than 1 month. In cases of partial work disability or activity limitations (ADL) the FCE is cost and time prohibitive. Likewise, the use of outcomes measurement derived solely from subjective measures (ie, Oswestry, NDI, VAS, and so forth) is inadequate for determining the functional status and rehabilitation goals of individuals whose symptoms or activity limitations have outlasted the expected natural history of their illness. The QFCE appears to be a means to assure quality while containing costs because it objectively measures functional limitations in a reliable and practical manner.

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