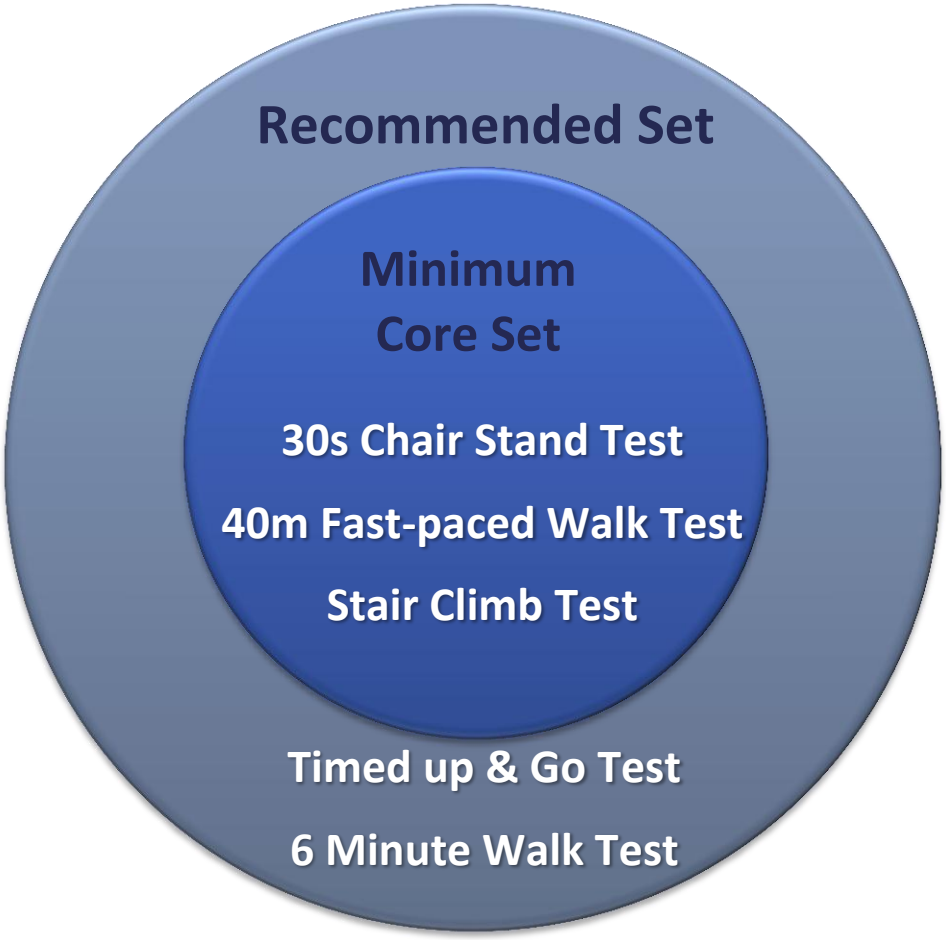
Recommended performance-based tests to assess physical function in people diagnosed with hip or knee osteoarthritis



OARSI Funded Initiative

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Background and Process

User Statement:

This OARSI recommended set of performance-based tests of physical function are best suited for older individuals (> 40 years) diagnosed with hip and/or knee osteoarthritis (OA), including end-stage disease or following joint replacement. They are intended for use by both clinicians and researchers as performance outcome measures and are viewed as complementary to established self-report measures such as questionnaires.

Although the tests in the recommended set were selected based on global expert opinion and available clinimetric evidence, none of the tests fulfil all desirable criteria, limiting the ability for a definitive core set of tests to be defined. Some tests described in the recommended set require further clinimetric evidence for people with OA, some require modifications to scoring procedures to enable more meaningful score interpretations and others require procedural modifications to standardize them across different clinical and research sites. Therefore this set of recommended tests represents what are considered the current best available tests as of January 2013.

Background:

A *Steering Committee* was established in 2011 to identify the best performance-based tests of physical function. With input from OARSI, an international, multidisciplinary *Advisory Group* (clinical and/or methods experts) was selected to provide a broad international representation; to represent both clinical and research expertise across the disease stages; and to encompass different disciplinary backgrounds. Members were also selected based on their international standing in OA practice and/or research and/or expertise in outcome measurement.

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Consensus process:

A consensus-based, decision analysis approach was used to select the performance-based measures of physical function. This was achieved using a series of online decision surveys using the 1000Minds program, a multi-attribute decision analysis research tool developed at the University of Otago, NZ [(1)]. An advantage of using 1000Minds over alternate consensus processes is that it is cognitively less challenging as it requires decisions on a series of pairs (alternate scenarios) rather than ranking numerous alternatives as the one time. Use of 1000Minds can also help guard against the "loudest voice" in a focus group situation. The program is user-friendly as long as participants have access to the internet. Analysis of participant's choices occurs in the background and group results are processed automatically and quickly regardless of how many participants are included in the task. 1000Minds has previously been used by the American College of Rheumatology/European League Against Rheumatology for expert consensus on the classification of rheumatoid arthritis [(2)].

Phases of project

Following consultation with the Advisory Group, the consensus process consisted of five progressive phases:

(1) Identification of candidate tests from review of the literature including a systematic review of the measurement properties of performance-based tests in older people with established hip and knee OA [(3)].

(2) An international expert consensus using 1000Minds to rank the difficulty of functional tests in people diagnosed OA to identify which tests were most applicable across the spectrum of functioning and more applicable to people with established OA.

(3) A large global consensus of both clinicians and researchers using 1000Minds survey to rank the feasibility (practical issues such as time required, cost, equipment, space, administration burden) of tests.

(4) A consensus of the advisory group using 1000Minds to identify the preferred performance-based tests based on feasibility, the available measurement property evidence identified in the systematic review and the scoring methods used.

(5) A meeting by the advisory group to select the *Recommended Set* (5 tests) and the *Minimal Core Set* (3 tests) *(see below)*.

Selected tests

The selected tests for the **Recommended Set** for people diagnosed with hip and knee OA are:

Recommended set of performance-based measures of physical function		
Recommended Activity	**Minimum core set**	**Recommended Test**
Sit-to-stand		30 second chair stand test
Walking short distances		4x10m fast-paced walk test
Stair negotiation		*[No test recommendation]*
Ambulatory transitions		Timed up and go test
Aerobic capacity / walking long distances		Six-minute walk test

Suggested guidelines for the use of the Timed Up and Go Test and Six Minute Walk Test are:

- To compare across different population groups
- To continue existing databases/research protocols /standard clinical testing
- In studies focusing on physical function as the main outcome dimension

Additional suggested guidelines for the use of the Six Minute Walk Test are:

- To compare function across the life spans (i.e. younger and older individuals with OA)
- When the interaction of co-morbidities on walking ability is the desired outcome (for example weight loss study)

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30-second Chair Stand Test

Abbreviation: 30s-CST

Purpose / Domains

A test of sit-to-stand activity.

Also a test of lower body strength and dynamic balance.

ICF code [1]*:* d410 Changing basic body position.

Description

The maximum number of chair stand repetitions possible in a 30 second period [2-4].

Equipment

- Timer/stop watch.
- Straight back chair with a 44cm (17 inch) seat height, preferably without arms.
- Same chair should be used for re-testing within sites.

Preparation

Environment

- Ensure the chair cannot slide backwards by placing the back of the chair against a wall.

Participant

- Comfortable walking footwear (e.g. tennis shoes/cross trainers) should be worn.
- The participant sits in the chair in a position that allows them to place their feet flat on the floor, shoulder width apart, with knees flexed slightly more than 90 degrees so that their heels are somewhat closer to the chair than the back of their knees.
- The arms are crossed at the wrists and held close to the chest (across chest).

Tester

- The tester stands close to the side of the chair for safety and so as they can observe the technique, ensure that the participant comes to a full stand and full sit position during the test.

Practice

- A practice trial of one or two slow paced repetitions is recommended before testing to check technique and understanding.

Procedure

- From the sitting position, the participant stands up completely up so hips and knees are fully extended, then completely back down, so that the bottom fully touches the seat. This is repeated for 30 seconds.
- Same chair should be used for re-testing within site.
- If the person cannot stand even once then allow the hands to be placed on their legs or use their regular mobility aid. This is then scored as an adapted test score.

Verbal instructions

"For this test, do the best you can by going as fast as you can but don't push yourself to a point of overexertion or beyond what you think is safe for you.

1. *Place your hands on the opposite shoulder so that your arms are crossed at the wrists and held close across your chest. Keep your arms in this position for the test.*
2. *Keep your feet flat on the floor and at shoulder width apart.*
3. *On the signal to begin, stand up to a full stand position and then sit back down again so as your bottom fully touches the seat.*
4. *Keep going for 30 seconds and until I say stop.*
5. *Get ready and START".*

Scoring

- On the signal to begin, start the stop watch. Count the total number of chair stands (up and down equals one stand) completed in 30 seconds. If a full stand has been completed at 30 seconds (i.e. standing fully erect or on the way down to the sitting position), then this final stand is counted in the total.
- The participant can stop and rest if they become tired. The time keeps going.
- If a person cannot stand even once then the score for the test is zero.
- Next, allow the hands to be placed on their legs or use their regular mobility aid. If the person can stand with adaptions, then record the number of stands as an adapted test score (see score sheet). Indicate the adaptations made to the test.

Minimal reporting standards

- Chair height.
- Adaptations – such as using hands on legs or using a walking aid.

N.B. The individual should use the assistive device (if any) they would normally use to perform the activity at the time of testing, irrespective of how they performed it previously. However, if an assistive device/rail is used, then it should be recorded for that occasion.

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Stair Climb Test

Abbreviation: *x*-step SCT (where *x* is the number of steps e.g. 9-step SCT)

Purpose / Domains

A test of ascending and descending stair activity.

Also a test of lower body strength and balance.

ICF codes [1]*:* d410 Changing basic body position, d455 Moving around, d4551 Climbing.

Description

The time (in seconds) it takes to ascend and descend a flight of stairs [2-6].
The number of stairs will depend on individual environmental situations.
Where possible, the 9-step stair test with 20cm (8 inch) step height and handrail is recommended.

Equipment

- Timer/stop watch.
- Flight of stairs.

Preparation

Environment

- Suitable step heights (between 16-20cm).
- Ensure adequate lighting and free from traffic and external distractions.

Participant

- Comfortable walking footwear (e.g. tennis shoes/cross trainers) should be worn.

Tester

- If safety is of concern, the tester should guard behind/below the participant going up the stairs and ahead/to the side coming down the stairs.
- If there is no concern for safety, the tester should remain at the start/finish position on the ground landing.

Practice

- A practice trial with tester guarding is recommended before testing to assess for safety.

Procedure

- Ascend and descend flight of stairs as quickly as possible but in a safe manner.
- Use of a handrail and walking aid is permitted if needed. Use should be recorded.
- Same stairs should be used for re-testing within site.

Verbal instructions

"For this test, do the best you can by going as fast as you can but don't push yourself to a point of overexertion or beyond what you think is safe for you.

1. *Start with both feet on the bottom landing.*
2. *On start, go to the top of the stairs as fast but as safe as you can, turn around and return back down and stop with both feet back on the ground landing.*
3. *Use the rail only if needed.*
4. *Get ready and START".*

Scoring

- Timing begins on the signal to start and terminates when the participant returns with both feet to the ground level.
- Total time to ascend and descend steps for 1 test trial is recorded to nearest 100th of a second.
- The participant can stop and rest if needed but the time keeps going.

Minimal reporting standards

- Number of stairs in flight and step height (rise).
- Use of hand rail (for ascent / descent / both) and side of hand rail.
- Use of walking aids.

N.B. The individual should use the assistive device (if any) they would normally use to perform the activity at the time of testing, irrespective of how they performed it previously. However, if an assistive device/rail is used, then it should be recorded for that occasion.

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40m (4x10m) Fast Paced Walk Test

Abbreviation: 40m FPWT

Purpose / Domains

A test of short distance walking activity.

A test of walking speed over short distances and changing direction during walking.

ICF codes [(1)]*:* d410 Changing basic body position, d450 Walking, d455 Moving around.

Description

A fast-paced walking test that is timed over 4 x 10m (33 ft) for a total 40 m (132 ft) [(2)].

Guidelines for use

- As a direct measure of the ability to walk quickly over short distances, which is an activity that is important but often limited in people with hip and/or knee OA.

Equipment

- Timer/stop watch.
- 10 m (33 ft) marked walkway with space to turn safely around at each end.
- 2 cones place approximately 2 metres beyond each end of the 10m walkway.
- Calculator to convert time to speed.

Preparation

Environment

- Mark out a 10 m (33 ft) walkway with bright coloured tape at each end.
- Place a cone approximately 2 metres before the start mark and 2 meters beyond the finish mark of the 10m walkway for turning.
- Ensure there is enough space to turn safely around at each end (i.e. 2-3m each end).

Participant

- Comfortable walking footwear (e.g. tennis shoes/cross trainers) should be worn.

Tester

- If safety is of concern, the tester should follow slightly behind and off to one side to the participant but not as to pace or impede them.
- If there is no concern for safety, the tester should follow well to the side so as they can view crossing at the 10m walkway at both ends.

Practice

- A practice trial of 1-2 turns is recommended before testing to check understanding.

Procedure

- Participants are asked to walk as quickly but as safely as possible, without running, along a 10 m (33 ft) walkway and then turn around a cone, return then repeat again for a total distance of 40 m (132 ft) (3 turns).
- Regular walking aid is allowed and recorded.

Verbal instructions

"For this test, do the best you can by going as fast as you can, without running, but don't push yourself to a point of overexertion or beyond what you think is safe for you.

1. *Start with both feet on the start line.*
2. *On start, walk as quickly but as safely as possible, without running.*
3. *Walk up to the end cone, turn around and walk back to the starting cone behind you, turn again and back to the end cone, then turn once more and return back to the start cone again so that you walk the 10m walkway 4 times in total.*
4. *Get ready and START".*

Scoring

- Timing starts on the signal to start at the start line and terminates once the participant crosses back over the start line after completing the 40 m (4x10 m).
- When the participant crosses the 10m mark, timing is paused whilst the participant turns around the cone and then is resumed once they cross the 10m mark again. The same is repeated for the following turns and is stopped once the participant crosses the start line for the final time.
- Time of one trial is recorded to the nearest 100th of a second.
- Time of one test trial is recorded and expressed as speed m/s by dividing distance (40m) by time (s).
- Regular walking aid is allowed and use should be recorded.

Minimal reporting standards

- Assistive devices such as usual walking aids - walking stick etc.

N.B. The individual should use the assistive device (if any) they would normally use to perform the activity at the time of testing, irrespective of how they performed it previously. However, if an assistive device/rail is used, then it should be recorded for that occasion.

REFERENCES

1. World Health Organization. International Classification of Functioning, Disability, and Health: ICF. Geneva, Switzerland 2001.

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Timed Up and Go Test

Abbreviation: TUG

Purpose / Domains

A "transition" test of ambulatory activity.

A test incorporating multiple activity themes including a test of sit-to-stand activity, a test of walking short distances and a test of changing direction during walking, and the transitions between the activities.

Also a test of strength, agility and dynamic balance.

ICF codes[1]*:* d410 Changing basic body position, d450 Walking, d455 Moving around.

Description

Time (seconds) taken to rise from a chair, walk 3 m (9 ft 10 inches), turn, walk back to the chair, then sit down wearing regular footwear and using a walking aid if required [(1-6)].

Equipment

- Timer/stop watch.
- Standard chair with arm rests: seat height approximately 44 cm (17") and arm rest height approximately 65 cm (26").
- Tape or other marker on the floor 3 m (9 ft 10 inches), away from the chair.

Preparation

Environment

- Ensure the chair cannot slide backwards by placing the back of the chair against a wall.
- Tape or other marker on the floor 3 m (9 ft 10 inches), away from the chair so that it is easily seen by the participant and with enough room to turn safely.

Participant

- Comfortable walking footwear (e.g. tennis shoes/cross trainers) should be worn.
- Sits in the chair with their back resting on the back of the chair and hands on armrests.
- May use usual walking aid but may not be assisted by another person.

Tester

- If safety is of concern, the tester stands to the side of the chair, then follows the participant to guard slightly behind and to one side but not as to pace or impeded turn.
- If there is no concern for safety, the tester remains at the start/finish position beside the chair.

[1] World Health Organization. International Classification of Functioning, Disability, and Health: ICF. Geneva, Switzerland 2001.

Practice

- A practice trial is recommended before testing to check technique and understanding.

Procedure

- Participants are asked to stand up, walk to a mark 3m (9.8 ft) away, turn around and return to sit back in the chair at their regular pace.
- Regular walking aid is allowed and recorded.
- Same chair is needed for re-testing.

Verbal instructions

"For this test, do the best you can and walk at your regular pace.

1. *Start by sitting in the chair with you back resting on the back rest and your hands on the arm rest.*
2. *On start, stand up, walk to the mark, turn around, return and sit back into the chair with your back resting on the back of the chair.*
3. *Walk at your regular pace.*
4. *Get ready and START".*

Scoring

- Timing starts on the signal to start and terminates once the participant sits back down fully with their back resting on the back of the chair.
- Regular walking aid is allowed and recorded if required.
- Two trials are performed and the faster of the 2 trials is recorded to nearest 10th of a second.

Minimal reporting standards

- Assistive devices such as usual walking aid - walking stick etc.

N.B. The individual should use the assistive device (if any) they would normally use to perform the activity at the time of testing, irrespective of how they performed it previously. However, if an assistive device/rail is used, then it should be recorded for that occasion.

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4. Mizner RL, Petterson SC, Clements KE, Zeni Jr JA, Irrgang JJ, Snyder-Mackler L. Measuring Functional Improvement After Total Knee Arthroplasty Requires Both Performance-Based and Patient-Report Assessments. A Longitudinal Analysis of Outcomes. J Arthroplasty. 2011;26(5):728-37.
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6. Wright AA, Cook CE, Baxter GD, Dockerty JD, Abbott JH. A comparison of 3 methodological approaches to defining major clinically important improvement of 4 performance measures in patients with hip osteoarthritis. J Orthop Sports Phys Ther. 2011;41(5):319-27. Epub 2011/02/22.

Six Minute Walk Test

Abbreviation: 6MWT

Purpose / Domains

A test of aerobic capacity and long distance walking activity.
Also a test of endurance and dynamic balance when changing directions during walking.
ICF codes[1]*:* d410 Changing basic body position, d450 Walking, d455 Moving around.

Description

A test of aerobic walking capacity over longer distances.
The maximal distance covered in a 6-minute period is recorded [1-6].

Equipment

- Flat walking area such as a hallway or open space, preferably >20m in length, with distance interval markings every 3-5 metres.
- Cones or bright colour tape to mark boundaries of course or turn points.
- Timer/stop watch.
- Chair(s) for resting if required e.g. at each end of walkway or placed around course.

Preparation

Environment

- Ensure the walkway is free from traffic.

Participant

- Comfortable walking footwear (e.g. tennis shoes/cross trainers) should be worn.

Tester

- If safety is of concern, the tester should follow behind and to one side of the participant but not as to pace or impede them.
- If safety is of no concern, the tester should remain close enough to observe the participant for any distress during testing.

Practice

- Practice test not normally required in the clinical setting.
- If performed as part of existing research protocols then at least 1 hour rest should be allowed before the second test and the greatest distance is then recorded.

Procedure

- The aim of this test is to walk as quickly as possible for six minutes to cover as much ground as possible.
- Rest periods are allowed but included in the time (i.e. time is not stopped for resting).
- Encouragement (e.g. “keep going you are doing really well”) is given at minute intervals
- Same course should be used for re-testing within site.

[1] World Health Organization. International Classification of Functioning, Disability, and Health: ICF. Geneva, Switzerland 2001.

Verbal instructions

"For this test, do the best you can by going as fast as you can, but don't push yourself to a point of overexertion or beyond what you think is safe for you.

1. *Start with both feet on the start line.*
2. *On start, walk as quickly but as safely as possible around the course / up and down the hallway.*
3. *Continue the course / walkway to cover as much ground as possible over 6 minutes.*
4. *Walk continuously if possible, but do not be concerned if you need to slow down or stop to rest. The goal is to feel at the end of the test that no more ground could have been covered in the 6 minutes.*
5. *You can sit down to rest if you require".*
6. *Get ready and START".*

Scoring

- The test starts on the signal to start and terminates at 6 minutes.
- The distance walked over the 6 minutes is recorded in metres.
- If walking aid is used it is recorded.

Minimal reporting standards

- Assistive devices such as usual walking aid - walking stick etc.
- Course dimensions e.g. single 20m walkway, 50m (20m x 5m x20x 5m) rectangular course.

N.B. The individual should use the assistive device (if any) they would normally use to perform the activity at the time of testing, irrespective of how they performed it previously. However, if an assistive device/rail is used, then it should be recorded for that occasion.

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Appendix 1: Clinimetrics in OA

Summary of clinimetric evidence available up to June 2012

Further information available in:

Dobson F, Hinman RS, Hall M, Terwee CB, Roos EM, Bennell KL. Measurement properties of performance-based measures to assess physical function in hip and knee osteoarthritis: a systematic review. Osteoarthritis Cartilage. 2012;20(12):1548-62. Epub 2012/09/05

Abbreviations

AUC	Area under the curve
CI	Confidence interval
ES	Effect size
ICC	Intraclass correlation coefficient
MCII	Minimal clinically important improvement
MDC_{90}	Minimal detectable change at 90% confidence
OA	Osteoarthritis
SD	Standard deviation
SEM	standard error of measurement
SRM	Standard response mean

30-second Chair Stand Test

Reliability

Intra-tester:

- $ICC_{1,1}$ 0.97-0.98 (95% CI: 0.94, 0.99) (within session) in end-stage hip and knee OA awaiting joint replacement (mean age 70.3years SD 9.8 years) [1]

Inter-tester:

- $ICC_{1,1}$ 0.93-0.98 (95% CI: 0.87, 0.99) in end-stage hip and knee OA awaiting joint replacement(mean age 70.3years SD 9.8 years) [1]
- $ICC_{2,1}$ 0.81 (95% CI: 0.63, 0.91) hip OA (mean age 66.5 SD 9.4 years) [2]

Measurement error:

- SEM of 1.3 repetitions and $MDC_{90\ of}$ 1.6 repetitions in Hip OA (mean age 66.5 SD 9.4 years)[2]
- SEM of 0.7 repetitions and MDC_{90} of 1.6 repetitions end-stage hip and knee OA awaiting joint replacement (mean age = 70.3 SD 9.8 years) [1]

Responsiveness:

- AUC 0.73 (0.55,0.91) in Hip OA (mean age 66.5 SD 9.4 years) after 9 physiotherapy/exercise sessions [2]

Interpretability:

- MCII: 2 - 3 stands in Hip OA (mean age 66.5 SD 9.4 years)[2]

Stair Climb Test

Reliability

Intra-tester:

- 4-step SCT: $ICC_{2,1}$ 0.94-0.96 (95% CI: 0.75, 0.99) in hip and knee OA (mean age 69.4 years SD 5.9 years) [3]

Inter-tester:

- 11-step SCT: $ICC_{2,1}$ 0.94 (95%CI: 0.55,0.98) in people following knee joint replacement (mean age 68 years SD 8 years) [4]

Test-retest:

- 9-step SCT: $ICC_{2,1}$ 0.90 (95% CI: 0.79,0.96) over a long interval (median 178 days) in end-stage hip and knee OA awaiting joint replacement (mean age 63.7 SD 10.7 years) [5]

Measurement error:

- 9-step SCT: SEM of 2.35s and MDC_{90} of 5.5s in end-stage hip and knee OA awaiting joint replacement (mean age = 63.7 SD 10.7 years) [5]

- 11-step SCT:SEM of 1.14 s and a MDC_{90} of 2.6 s in people following knee joint replacement (mean age 68.0 years SD 8.0 years) [4]

Responsiveness:

- 9-step SCT :responsive to detecting initial deterioration (SRM = -1.74 (95% CI: -2.13, -1.45) then subsequent improvement (SRM = 1.98 (95% CI: 1.68, 2.42) following hip or knee joint replacement (mean age 63.7 SD 10.7 years) [5]
- 12-step SCT responsive to detecting initial deterioration(ES = -0.71) then subsequent improvement (ES – 0.84) following knee joint replacement (mean age 65.5 SD 9.0 years) [6]

Interpretability:

- No information found in people with OA

40m (4x10m) Fast Paced Walk Test

Reliability

Inter-tester:

- $ICC_{2,1}$ 0.95 (95% CI: 0.90 0.98) hip OA (mean age 66.5 SD 9.4 years) [2]

Measurement error:

- SEM of 1.0 m/s and MDC_{90} of 2.3 m/s in Hip OA (mean age 66.5 SD 9.4 years)[2]

Responsiveness:

- AUC 0.89 (0.76, 1.00) Hip OA (mean age 66.5 SD 9.4 years) after 9 physiotherapy/exercise sessions [2]

Interpretability:

- MCII 0.2-0.3 m/sec Hip OA (mean age 66.5 SD 9.4 years)[2]

Time Up and Go Test

Reliability

Inter-rater:

- $ICC_{2,1}$:0.87 (95% CI:0.63, 0.91) in 29 people with hip OA (mean age 66.5 SD 9.4 years) when tested within a 7 day period [2]

Test-retest:

- $ICC_{2,1}$ 0.75 (95% CI: 0.51, 0.98) over a long interval (median 178 days) in end-stage hip and knee OA awaiting joint replacement (mean age 63.7 SD 10.7 years) [5]

Measurement error:

- SEM of 0.84s in Hip OA (mean age 66.5 SD 9.4 years)[2]
- A SEM of 1.07 s (95% CI: 0.86,1.41) and a MDC_{90} of 2.49 s was found in a sample of 21 people with end-stage hip and knee OA awaiting arthroplasty (mean age = 63.7 SD 10.7 years) [5]

Responsiveness:

- AUC 0.69 (0.48, 0.90) in Hip OA (mean age 66.5 SD 9.4 years) after 9 physiotherapy/exercise sessions [2]
- A small effect size (ES = 0.33, SRM = 0.35, median change score = 1s) in knee OA following physiotherapy intervention. [7]
- Responsive in detecting initial deterioration (SRM = -1.08 (95% CI: -1.38-0.92) and then subsequent improvement (SRM = 1.04 (95% CI: 0.84,1.61) in the early postoperative period following hip or knee joint replacement (mean age = 63.7 SD 10.7 years) [5]

Interpretability:

- MCII 0.8-1.4 s Hip OA (mean age 66.5 SD 9.4 years)[2]

Six Minute Walk Test

Reliability

Test-retest:

- ICC2,1 0.94 (95% CI: 0.88,0.98) over a long interval (median 178 days) in end-stage hip and knee OA awaiting joint replacement (mean age 63.7 SD 10.7 years) [5]

Measurement error:

- SEM of 26.9m (95% CI: 21.1,34.8) and MDC_{90} of 61.3m in end-stage hip and knee OA awaiting joint replacement (mean age = 63.7 SD 10.7 years) [5]

Responsiveness:

- responsive to detecting initial deterioration (SRM = -1.74 (95% CI: -1.60, -1.97) then subsequent improvement (SRM = 1.90 (95% CI: 1.46,2.39) following hip or knee joint replacement (mean age 63.7 SD 10.7 years) [5]
- A small effect size (ES = 0.43, SRM = 0.54, median change score = 35m) in knee OA following physiotherapy intervention [7]
- Responsive for evaluating early (first 4 months) recovery after knee joint replacement (ES 0.82, SRM 1.51) (mean age =68.6 SD 8.7 years)[8]

Interpretability:

- No information found in people with OA

1. Gill S, McBurney H. Reliability of performance-based measures in people awaiting joint replacement surgery of the hip or knee. Physiother Res Int. 2008;13(3):141-52.
2. Wright AA, Cook CE, Baxter GD, Dockerty JD, Abbott JH. A Comparison of 3 Methodological Approaches to Defining Major Clinically Important Improvement of 4 Performance Measures in Patients With Hip Osteoarthritis. J Orthop Sports Phys Ther. 2011;41:319-27. Epub 2011/02/22.
3. Lin YC, Davey RC, Cochrane T. Tests for physical function of the elderly with knee and hip osteoarthritis. Scand J Med Sci Sports. 2001;11(5):280-6.
4. Almeida GJ, Schroeder CA, Gil AB, Fitzgerald GK, Piva SR. Interrater reliability and validity of the stair ascend/descend test in subjects with total knee arthroplasty. Arch Phys Med Rehabil. 2010;91(6):932-8.
5. Kennedy DM, Stratford PW, Wessel J, Gollish JD, Penney D. Assessing stability and change of four performance measures: a longitudinal study evaluating outcome following total hip and knee arthroplasty. BMC Musculoskelet Disord. 2005;6:3.
6. Mizner RL, Petterson SC, Clements KE, Zeni Jr JA, Irrgang JJ, Snyder-Mackler L. Measuring Functional Improvement After Total Knee Arthroplasty Requires Both Performance-Based and Patient-Report Assessments. A Longitudinal Analysis of Outcomes. J Arthroplasty. 2011;26(5):728-37.
7. French HP, Fitzpatrick M, FitzGerald O. Responsiveness of physical function outcomes following physiotherapy intervention for osteoarthritis of the knee: an outcome comparison study. Physiotherapy. In press.
8. Parent E, Moffet H. Comparative responsiveness of locomotor tests and questionnaires used to follow early recovery after total knee arthroplasty. Arch Phys Med Rehabil. 2002;83(1):70-80.

Appendix 2 - Score sheets and normal values

30-second Chair Stand Test Score Sheet

Verbal instruction:

"For this test, do the best you can by going as fast as you can but don't push yourself to a point of overexertion or beyond what you think is safe for you.

1. *Place your hands on the opposite shoulder so that your arms are crossed at the wrists and held close across your chest. Keep your arms in this position for the test.*
2. *Keep your feet flat on the floor and at shoulder width apart.*
3. *On the signal to begin, stand up to a full stand position and then sit back down again so as your bottom fully touches the seat.*
4. *Keep going for 30 seconds and until I say stop.*
5. *Get ready and START".*

Complete practice trial (1-2 repetitions to check form and understanding).

Time point Date	Chair seat height (cm)	**Score** (Repetitions in 30 seconds)	Adaptations	Adapted score
1. / /	cm		☐ Uses hands on legs ☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused	
2. / /	cm		☐ Uses hands on legs ☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused	
3. / /	cm		☐ Uses hands on legs ☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused	
4. / /	cm		☐ Uses hands on legs ☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused	
5. / /	cm		☐ Uses hands on legs ☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused	

Normal values

Normative scores (i.e. between the 25% and 75% percentiles) for the 30-s CST in community dwelling older people aged 60-94 years [1]

Age range	Average count for women	Average count for Men
60-64	12 to 17	14 to 19
65-69	11 to 16	12 to 18
70-74	10 to 15	12 to 17
75-79	10 to 15	11 to 17
80-84	9 to 14	10 to 15
85-89	8 to 13	8 to 14
90-94	4 to 11	7 to 12

Risk zone for falls: Scores of less than 8 stands for women and men [2].

1. Rikli RE, Jones CJ. Functional fitness normative scores for community-residing older adults, ages 60–94. J of Aging and Physical Activity. 1999;7:162-81.

2. Jones CJ, Rikli RE. Measuring functional fitness of older adults. The Journal on Active Aging. 2002;March-April:24-30.

40m (4 x 10m) Fast Paced Walk Test Score Sheet

Verbal instruction:

For this test, do the best you can by going as fast as you can, without running, but don't push yourself to a point of overexertion or beyond what you think is safe for you.

1. *Start with both feet on the start line.*
2. *On start, walk as quickly but as safely as possible, without running.*
3. *Walk to the mark 10m away, return to the start line, back again to the 10m mark, then return to the start line again so that you walk the 10m walkway 4 times in total.*
4. *Get ready and START".*

Complete practice trial of 1-2 turns to check understanding.

Date	Assistive walking aid (list)	**Time** (seconds: 00.00)	**Speed** (40/time in seconds) (0.00 m/sec)	Adaptations
1. / /				☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
2. / /				☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
3. / /				☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
4. / /				☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
5. / /				☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused

Normal values

Normative fast speed reference values m/s (SD) for healthy adults [1]

Age decade	Maximal speeds (m/s) mean (SD) women	Converted time over 40m distance (s) women	Maximal speeds m/s mean (SD) men	Converted time over 40m distance (s) men
40s	2.12 (0.28)	18.87	2.46 (0.36)	16.26
50s	2.01 (0.26)	19.90	2.07 (0.45)	19.32
60s	1.77 (0.25)	22.60	1.93 (0.36)	20.73
70s	1.75 (0.28)	22.86	2.08 (19.6)	19.24

(Note: these values are for gait speed over 1 x 7.62m (25 ft) walk distance only and exclude acceleration and deceleration times. Participants were asked to walk as fast as they could without running)

1. Bohannon RW. Comfortable and maximum walking speed of adults aged 20-79 years: reference values and determinants. Age Ageing. 1997;26(1):15-9.

Stair Climb Test Score Sheet

Verbal instruction:

"For this test, do the best you can by going as fast as you can but don't push yourself to a point of overexertion or beyond what you think is safe for you.

5. *Start with both feet on the bottom landing.*
6. *On start, go to the top of the stairs as fast but as safe as you can, turn around and return back down and stop with both feet back on the ground landing.*
7. *Use the rail only if needed.*
8. *Get ready and START".*

Date	Number of stairs	Step height (cm)	**Time** (seconds 00.00)	Adaptations
1. / /				☐ Uses handrail ascent/decent/both ☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
2. / /				☐ Uses handrail ascent/decent/both ☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
3. / /				☐ Uses handrail ascent/decent/both ☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
4. / /				☐ Uses handrail ascent/decent/both ☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
5. / /				☐ Uses handrail ascent/decent/both ☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused

Normal values

Normative scores available only for the ***12-step Stair Test***

	Men			Women		
	Mean (s)	SD(s)	n	Mean (s)	SD (s)	n
Healthy	8.72	2.58	27	10.22	2.61	38
Moderate OA	11.78	4.70	71	19.48	9.30	72
End-stage OA	17.43	8.35	77	23.59	9.81	67
1 month post TKR	23.53	10.82	104	30.58	12.56	91
3 month post TKR	12.33	4.87	100	15.50	4.85	83
6 months post TKR	11.64	3.85	118	15.27	6.10	101
12 months post TKR	11.17	3.85	139	15.04	6.17	66
24 months post TKR	11.70	4.09	87	15.48	6.18	138

Data obtained from the OA Profile website, maintained by the Department of Physical Therapy at the University of Delaware. TKR = total knee replacement

Timed Up and Go Test Score Sheet

Verbal instruction:

"For this test, do the best you can and walk at your regular pace.

5. *Start by sitting in the chair with you back resting on the backrest and your hands on the armrest.*
6. *On start, stand up, walk to the mark, turn around, return to sit back into the chair with your back resting on the back of the chair.*
7. *Walk at your regular pace.*
8. *Get ready and START".*

Complete a practice trial to check understanding.

Date	Assistive walking aid	**Time** (seconds: 00.00)	Adaptations
1. / /			☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
2. / /			☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
3. / /			☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
4. / /			☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
5. / /			☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused

Normal values

Normative age reference [1]

Age Group	Time (s) (95% CI)
60 – 69 yrs	8.1 (7.1, 9.0)
70 – 79 yrs	9.2 (8.2, 10.2)
80 – 99 yrs	11.3 (10.0, 12.7)

Older adults who take longer than 14 s to complete the TUG have a high risk for falls [2].

1. Bohannon RW. Reference values for the timed up and go test: a descriptive meta-analysis. J Geriatr Phys Ther. 2006;29(2):64-8.
2. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Phys Ther. 2000;80(9):896-903.

Six Minute Walk Test Score Sheet

Verbal instruction:

"For this test, do the best you can by going as fast as you can, but don't push yourself to a point of overexertion or beyond what you think is safe for you.

1. *Start with both feet on the start line.*
2. *On start, walk as quickly but as safely as possible around the course / up and down the hallway.*
3. *Continue the course / walkway to cover as much ground as possible over 6 minutes.*
4. *Walk continuously if possible, but do not be concerned if you need to slow down or stop to rest. The goal is to feel at the end of the test that no more ground could have been covered in the 6 minutes.*
5. *You can sit down to rest if you require".*
6. *Get ready and START".*

Date	Walking aid	Step height (cm)	**Distance** (metres)	Adaptations
1. / /				☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
2. / /				☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
3. / /				☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
4. / /				☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused
5. / /				☐ Uses walking aid ☐ Not tested – Unable ☐ Not tested - refused

Normal values

Distances in healthy individuals aged 60-89 years [1]

	Males			Females		
Age	**Mean (m)**	**SD (m)**	**95% CI**	**Mean (m)**	**SD (m)**	**95% CI**
60-69yrs	572	92	521-623	538	92	497-579
70-79yrs	527	85	478-575	471	75	440-507
80-89yrs	417	73	356-478	392	85	345-440

Risk zone of falls: less than 320 m [2]

6MWT distances were found to be associated with age and height in males and age, height and BMI in females. Regression equations to predict 6MWT in middle-aged and elderly adults are [3]:

Males: 6MWT (m) = 867 – (5.71 age, years) + (1.03 height, cm).

Females: 6MWT (m) = 525 – (2.86 age, years) + (2.71 height, cm) – (6.22 BMI).

1. Steffen TM, Hacker TA, Mollinger L. Age- and gender-related test performance in community-dwelling elderly people: Six-Minute Walk Test, Berg Balance Scale, Timed Up & Go Test, and gait speeds. Phys Ther. 2002;82(2):128-37.
2. Jones CJ, Rikli RE. Measuring functional fitness of older adults. The Journal on Active Aging. 2002;March-April:24-30.
3. Jenkins S, Cecins N, Camarri B, Williams C, Thompson P, Eastwood P. Regression equations to predict 6-minute walk distance in middle-aged and elderly adults. Physiotherapy Theory and Practice. 2009;25(7):516-22.