

NEUROMUSCULAR FUNCTION

Chair Stands, 6 Meter Walking Test, Balance Tests

1. Background and Rationale

Direct assessments of physical performance have become standard measurements in epidemiological studies in the elderly. These assessments generally tap multiple domains of physiological performance, including lower extremity strength, balance, coordination, and flexibility. The assessment techniques used in MrOS have been derived from several previous studies, are reliable when performed in a standardized fashion, and are well tolerated by elderly participants. The following assessments are included in the MrOS performance battery: single and multiple chair stands, a short walk test at usual pace, and balance tests.

2. Equipment and Supplies

- Digital stopwatch (repeated chair stands, standing balance, short walk test)
- Standard chair: straight back, flat, level, firm seat; seat height 45 cm at front (single and repeated chair stands).
- Walking course (See drawing included in description of 6 m Usual Pace)

2.1 Stopwatch Use



The stopwatch will be used to measure the time it takes to complete a task from the beginning of the activity until the conclusion. Press the middle (mode) button to make sure you are in stopwatch mode. The display should read **0:0000**. To time the task, just press the right-hand button (labeled STA/STP) at the top of the stopwatch to begin, and press again when the task is completed. The time is digitally displayed on the stopwatch. To get the display to read **0:0000** again, press the left (lap) button.

3. **Safety Issues and Exclusions**

Walking aids may not be used in the chair stand test. The vast majority of participants should be able to attempt the performance tests. Exclusion from the performance tests will be based on an individualized assessment of impairments and safety concerns. The examiner will describe each test, and then discuss with the participant whether they should attempt that test given any physical problems or disabilities present. Refusal or inability to perform a test will be recorded on the data form.

Obstructions in the exam area that could cause accidents should be removed. The detailed protocols describe how to administer the tests safely, including instructions on how to support the participant if required. For all test items where loss of balance is a possibility, you should use the following safety precautions. Position yourself standing at the participant's side, slightly behind them. Your hands should be positioned very close to either side of the participant's trunk at the hip or waist level but not touching the participant. Be ready to place both hands on the participant to stabilize them if necessary. If the participant loses balance, immediately hold onto the participant with both hands at the trunk and stabilize them. If the participant begins to fall do not try to catch them; reach under the participant's shoulders from behind and slowly ease them down to the floor. This will protect the participant and examiner from injury.

If the participant falls and is not injured, help them up by first having the participant get on their knees or on all fours, place a chair next to the participant, and have the participant support themselves on the chair as you help lift under the shoulders. Do not try to lift the participant from the floor by yourself.

4. **Participant and Exam Room Preparations**

- Footwear: To eliminate the effect of different footwear on test performance, these tests should be performed in tennis shoes or comfortable walking shoes with minimal or no heels. The participant may perform the tests in socks / stocking or bare feet if appropriate footwear is not available. Clinics may want to purchase a few sizes of inexpensive tennis shoes to have available.
- The standard chair should be placed on a nonslip surface (low pile carpeting works well) with the back of the chair against a wall for stability. There should be adequate room in front and on the sides of the chair for the examiner and the participant to maneuver freely.
- Walking course layout: The walk will be conducted on a six-meter path in a corridor at least 122 cm wide, without obstructions or irregularities in the floor. The start and finish lines will be marked by tape on the floor. (See figure under 5.6 Six Meter Usual Pace: Administration)

5. Measurement Procedures

5.1 Approach to Standardization

The Performance Based Measurements are administered by a certified examiner. Since motivation and level of understanding can have large impacts on performance, each component of the exam should be administered strictly according to the protocol and in the following sequence:

- Explain the procedure to the study participant making sure that key points from the suggested script are conveyed.
- Demonstrate the procedure using suggested script.
- Ask the participant if they have any questions.
- Re-explain the procedure briefly using suggested script.
- Ask the participant to perform the procedure.
- Begin all timed procedures with the words, "Ready? Go!"

Instructions and encouragement: Use the script provided to make sure that all key points are covered when you describe the test and how to perform it properly. You should not provide additional description or encouragement beyond the key points provided by the standard scripts.

If a participant questions the need for detailed verbal instruction, respond that you explain each test in detail since this is the best way to make sure that everyone does the test in a similar manner.

Demonstration: Demonstrate each maneuver for the participant. Remind the participant not to begin to do the maneuver until after you have demonstrated it.

It is very important that the examiner demonstrate each exercise correctly. Experience has shown that participants follow more closely what the examiner does rather than what they say. If the position or exercise is demonstrated incorrectly, the participant following the example will do the exercise incorrectly and be scored as "Unable" even though they may actually have been able to perform it correctly.

If the participant indicates that they do not understand the exercise, demonstrate it again rather than relying on repeated verbal instructions. Repeat the demonstration only once. If the participant still does not understand, go on to the next component of the test.

Practice trial: Practice trials for each test should be limited to those described in the individual measurement procedures.

Rest: The participant should be allowed to rest between tasks if out of breath or fatigued during the assessments.

5.2 General Scoring Issues

Not attempted/refused: If a test is not attempted because the participant refuses or the examiner deems the test unsafe for the participant, for whatever reason, record “not attempted/refused” on the scoring form. Where indicated, record a reason for the refusal.

Unable: If a test is attempted but cannot be completed or scored, record “unable” on the scoring form. Again, where indicated, record a reason.

5.3 Introductory Script and Exclusions for Performance Tests

The participant should be encouraged to perform each test if possible. However, they should also be instructed not to attempt a test if they feel it would be unsafe.

Script: “I’m going to ask you to try to do several different movements of your body. I will first describe and show each movement to you. Then I’d like you to try to do it. If you cannot do a particular movement or you feel it would be unsafe to try to do it, tell me and we’ll move on to the next one. Let me emphasize that I would like you to try each exercise. But I don’t want you to try to do any exercise that you feel might be unsafe.”

Record Impairments/Appliances: Record use of aids on the form.

Script: “Do you use any walking aids, such as a cane?”

Identify if the participant has any of the following. Record it on the form.

1) *Participant use of a lower extremity orthosis*

Orthosis - an orthopedic appliance or apparatus used to support, align, prevent or correct deformities or to improve the function of moveable parts of the body. In this exam we are specifically checking for lower extremity orthoses; plastic or metal leg braces at or above the ankle.

This refers to the participant's current use of such an aid. They will be wearing the device at the clinic for the exam. An orthosis used at other times (at night, for instance) is not recorded here.

An orthosis worn below the ankle (for example, a device worn in the shoes for fallen arches) does not qualify in this definition. If you cannot determine whether the participant uses an orthosis ask them.

2) *Missing limb*

Major limbs only are considered here: arms (including hands) and legs (including feet). A missing finger or other digit does not constitute a missing limb. A limb is considered missing whether or not an artificial limb is replacing the natural body part.

3) *Participant use of prosthesis*

Prosthesis - an artificial substitute for a missing body part, such as an arm or leg, used for functional or cosmetic purposes, or both.

If the participant is missing a limb, the use of an artificial limb or prosthesis is to be recorded here. This refers to the participant's current use of such an aid. They will be wearing the device at the clinic for the exam. If the participant has mentioned owning prosthesis but is not currently wearing it, it is not to be recorded here. If you cannot determine whether the participant is wearing prosthesis ask them.

NOTE: Use of appliances or missing limbs are not exclusion criteria for these tests.

4) *Paralysis of an extremity or side of body*

If the participant is unable or has difficulty moving an arm and/or leg due to weakness or spasticity, record this here. Only obvious impairment need be recorded. The examiner is not expected to elicit subtle neurologic signs.

Screen for health status:

Script: “Do you have any problems from recent surgery, injury, or other health conditions that might prevent you from standing up from a chair or walking?”

If the answer is “yes,” record on the form. Tell the participant who says “yes” that after you describe each test to them, you will discuss whether they should attempt the test given their physical problems. If no problems are mentioned by the participant, mark “no”.

5.4 Single Chair Stand: Administration

This is a test of ability to stand up from a standard chair without using arms. This task is also used to screen for the ability to do repeated chair stands. Walking aids such as canes, walker, or crutches may not be used.

- 1) **Participant and Exam Preparation:** A straight-backed chair without arms, with seat height of 45 cm, should be used for this test and placed against a wall for added stability. The participant's feet should be placed squarely on the floor in front of them. The participant should be seated in a position which allows them to place their feet on the floor with knees flexed to slightly greater than 90° so that their heels are somewhat closer to the chair than the back of the knees.

During the test, the examiner may stand in front of the participant (with arms extended, if appropriate) for the participant's safety during the chair stands.

- 2) Describe the test:

Script: "This is a test of strength in your legs in which you stand up from sitting without using your arms."

- 3) Demonstrate the procedure:

Script: "Fold your arms across your chest, like this, and stand, keeping your arms in this position. Do you understand?"

- 4) Ask the participant to stand:

Script: "Can you stand and sit one time for practice? Ready, Go!"

If the arms unfold, or the participant puts one or both hands down on the chair to push up, remind them to keep their arms folded snugly across their chest and ask them to repeat the chair stand.

It is OK for the participant to move part-way forward in the chair before standing, but knees and hips should be flexed to approximately 90° before standing.

- 5) If the participant cannot rise without using arms, say:

Script: "OK. Try to stand up using your arms to push off."

- 6) Answer if the participant could stand up one time unassisted. Score as follows:

If the procedure was not performed for safety reasons or refused for other reasons, score "*Did not attempt/refused.*" Do not perform Repeated Chair Stands!

If participant attempted but was unable to arise even using their arms, score as "*No, unable to stand.*" Do not perform Repeated Chair Stands!

If the participant uses arms to stand up, score as "*No, rises using arms.*" Do not perform Repeated Chair Stands!

If the participant stood up all the way without using arms, score as "*Yes.*" Go on to Repeated Chair Stands.

5.5 Repeated Chair Stands: Administration

This is a test of lower extremity strength in which the participant stands up from a seated position five times as quickly as possible. The time it takes to stand five times is recorded.

- 1) If the participant can arise from the chair without using arms, attempt the five stands.

Script: "This time, I want you to stand up 5 times as quickly as you can keeping your arms folded across your chest."

2) Demonstrate the test.

Cross your arms over your chest and then rise while emphasizing “full standing position”, and sit while emphasizing “all the way down.”

Script: “First I will show you. When you stand up, come to a full standing position each time, and when you sit down, sit all the way down each time. I will demonstrate two chair stands to show you how it is done.”

Rise two times as quickly as you can, counting as you stand each time.

3) Begin the test

Script: "When I say ‘Go’ stand five times in a row, as quickly as you can, without stopping. Stand up all the way, and sit all the way down each time. Ready, Go!"

Start timing as soon as the examiner says “Go.” Count: "1, 2, 3, 4, 5" as the participant stands each time.

4) If the participant is unable to complete the chair stands correctly (e.g. is not coming to a full stand), abort the procedure, repeat the demonstration, wait 1 minute, and begin the procedure again.

5) If the participant stops before completing five stands, confirm that they cannot continue by asking:

Optional script: "Can you continue?"

If they say yes, continue timing. Otherwise, stop the stopwatch.

6) Score as follows:

When 5 stands weren’t completed:

If the procedure was not performed for safety reasons or refused for other reasons, score *“Did not attempt/refused.”*

If participant attempted and completed at least one stand but was unable to complete five stands, score as *“Completed at least 1 stand, but unable to complete 5 without help.”* Record the number of stands that were completed.

If the participant attempted but was unable to stand once without help, score as *“Attempted, but unable to stand once without help.”* Record that 0 stands were completed.

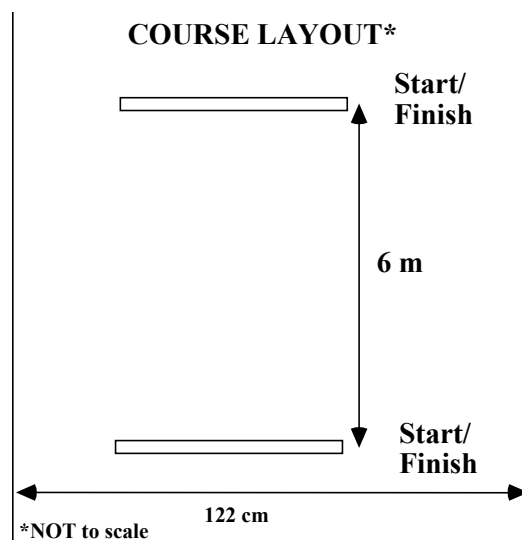
When 5 stands were completed:

Record the number of seconds, to a hundredth of a second, required to complete five stands. Also, record participant’s arm use during the chair stands.

5.6 Six Meter Usual Pace: Administration

This is a modification of the short walk test used in many epidemiological and clinical studies. The time to walk 6 m at the participant's usual pace is measured, along with the number of steps.

The 6 m walking course is laid out on the floor as indicated in the figure below. The course must be free of obstacles. Please note that at previous MrOS visits, a 6 m narrow walk was completed. The course for the 6 m course included lines along the course 20 cm apart (as noted on the figure below). It is not necessary to have these 20 cm apart lines for the 6 m usual pace walk. However, it is acceptable for these 20 cm apart lines to remain on the course used for the 6 m walk. Sites should instruct participants to ignore those lines during the 6 m usual pace walk.



Starting Each Walk Test: The participant should stand with toes just touching the starting line. Clearly indicate the beginning of the test. Say “Ready, Go.” Start timing with the first footfall over the starting line (participant’s foot touches the floor on the first step).

Scoring the Walks: Stop timing with the first footfall (complete or partial) crosses the finish line. Time is recorded to the nearest 0.01 second. For the usual pace walk, also count all steps. Steps are counted by counting both right and left steps and include the initial starting step and the step that first touches the floor across the finish line.

1) Introduction

Describe the walking test.

Script: “This is a walking test. I want you to walk down the hall normally, at a comfortable pace, ignoring the colored lines (if they are present). I will ask you to do this walk twice.”

2) Usual pace walk

- a) Demonstrate the usual pace test: Say the following, while demonstrating where to place the feet and where to walk.

Script: “Place your feet with your toes behind, but touching the starting line. Wait until I say ‘GO.’ Remember, I want you to walk at a comfortable pace ignoring the colored lines.” (Demonstrate and return.) “Walk a few steps past the finish line each time. Any questions.”

- b) Complete Trial 1. Clearly begin the trial, saying:

Script: “Ready, Go.”

Start timing with the participant’s first footfall. Follow along a few paces behind the participant. Count each step (NOT aloud), both left and right. Hit the start button on the stopwatch as you count the first step. Stop timing with the first footfall (complete or partial) crosses the finish line.

- c) Have the participant repeat the usual pace walk.

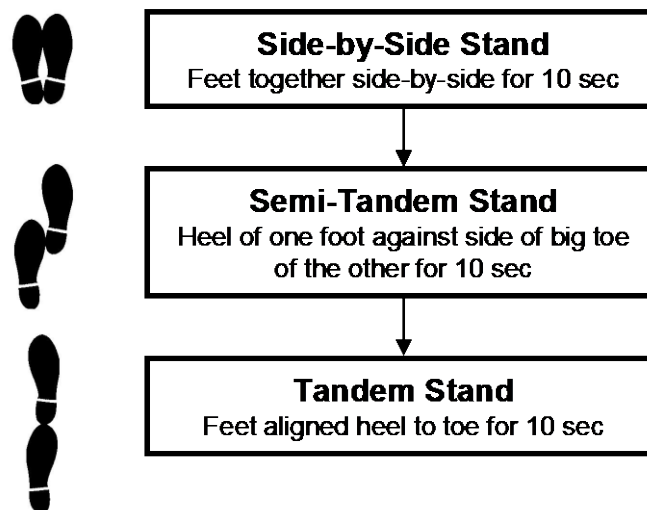
Script: “OK, fine. Now turn around and when I say go, walk back the other way at a comfortable pace. Ready, GO.”

- d) For each trail, record if the trial was completed. If the trial was completed, record the time and the number of steps. Also record aid use. If the participant wasn’t able to complete a trail, score “*Participant attempted but unable.*” If a trial wasn’t completed, score “*Unable to assess.*”

5.7 Balance Tests

5.7.1 Overview

This is a series of timed, progressively more difficult, static balance tests. Participants are asked to hold each position (side-by-side, semi-tandem, and tandem stand) for 10 seconds, and the one-leg stand for 30 seconds. If the participant is not able to hold a position for amount of time specified, the time (in seconds) the position was held is recorded. All trials are performed with eyes open. Each test is timed and the participant is allowed only one chance to maintain each position.



Participants taking this test must be able to stand unassisted without using a cane or a walker. Don't assume that a participant who arrives for testing using a cane or walker can't stand unassisted. Ask them if they can stand without the device and are willing to try the test. If they say yes, you can assist them to assume the correct position for testing. If they cannot perform the test without assistance, record "Participant could not hold position unassisted" and go on to the next clinic exam.

For each stand, describe the position to the participant and then demonstrate it. Demonstrate while facing the participant. After demonstrating, approach the participant from the front and offer them your arm for support while they get in position. Many participants will need little support to help them into position but others will need strong support until they are in position and steady. If you cannot steady them with support, then do not try the test. Record "Not attempted, examiner felt unsafe" and go on to the next clinic exam.

If the participant feels it would be unsafe to try, probe for the reason, and reassure the participant that you will help them into the position and that they will be close to the wall (or other form of support) for additional support. Participants who simply feel they cannot do it should be encouraged to try. If they still feel they should not attempt it, record, "Not attempted, participant felt unsafe" and go onto the next clinic exam.

All procedures should be clearly demonstrated to the participant prior to performing any test and they should be queried to ensure that they understand the instructions. If the participant still does not understand the instructions, record “Participant unable to understand instructions” and go on to the next clinic exam.

If the participant refuses for another reason, mark “Participant refused” and go on to the next clinic exam. If there is another reason the test is not complete, mark “Other” and specify the other reason.

Describe the series of tests to the participant and demonstrate each position. Ask the participant if they feel they would be able to perform the tests. Time each stand. After 10 seconds for the side-by-side, semi-tandem, and tandem stands; and 30 seconds for the one-leg stand, tell the participant to stop. If the participant loses balance prior to the specified amount of time given, record the number of seconds for which the stand was held.

Script: “I’m going to ask you to stand in several different positions that test your balance. I’ll demonstrate each position and then ask you to try to stand in each position for a number of seconds. I’ll be near you to provide support, and the wall (or other support) is close enough to prevent you from falling if you lose your balance. Do you have any questions?”

5.7.2 Side-by-Side Stand

The first position tested is the side-by-side stand. In this balance test, participants are requested to stand for 10 seconds with their feet together in a side-by-side position. Participants who are unable to hold the side-by-side stand for less than 10 seconds do not proceed further with the balance tests. Participants who successfully complete the side-by-side test proceed to the semi-tandem balance test.

Make sure that the participant is stable and that their feet are in the correct position. Have the stopwatch ready to begin timing as soon as they release your arm. During this and all other balance tests, the examiner should stand next to the participant as they get into position and then step back a half step as they perform the test. It is important not to crowd the participant so much that they have trouble using their arms to keep their balance. On the other hand, you must be close enough to grab their arm or let them grab your arm if they lose their balance. Based on prior experience, most participants simply step out of position if they lose balance.

- a) Describe the position.

Script: “First I would like you to try to stand with your feet together for about 10 seconds. Please watch while I demonstrate.”

- b) Demonstrate and say:

Script: “You can use your arms and body to maintain your balance. Try to hold your feet in position until I say stop.”

Stand next to the participant to help him into the side-by-side position. Supply just enough support to the participant’s arm to prevent loss of balance.

- c) Begin the test. Allow the participant to hold onto your arm to get balanced. Say:

Script: “You may hold onto my arm while you get in position. When you are ready, let go. Are you ready?”

Say “Ready, begin”, and start timing when the participant lets go.

(If the participant does not hold onto your arm, say “Ready, begin” and start timing when they are in position.)

Say, “STOP” after 10 seconds or when the participant steps out of the position or grabs a support.

If the participant is unable to hold the position for 10 seconds, do not attempt the other balance tests. Record to 0.01 second how long participant is able to hold this position and go to the next clinic exam.

5.7.3. Semi-Tandem Stand

In the semi-tandem balance test, each participant starts with the heel of one foot placed to the side of the big toe of the other foot. Either foot can be placed in the forward position. Participants who are unable to hold the semi-tandem stand for less than 10 seconds do not proceed further with the balance tests. Participants who successfully complete the semi-tandem stand proceed to the next balance test. If the participant successfully completed the side-by-side stand but did not attempt the semi-tandem stand, record the reason on the data collection form.

- a) Describe the position.

Script: “Next I would like you to try to stand with the side of the heel of one foot touching the big toe of the other foot for about 10 seconds. Please watch while I demonstrate.”

- b) Demonstrate and say:

Script: “You may put either foot in front, whichever is more comfortable. You can use your arms and body to maintain your balance. Try to hold your feet in position until I say stop. ”

Stand next to the participant to help him into the semi-tandem position. Supply just enough support to the participant’s arm to prevent loss of balance.

- c) Begin the test. Allow the participant to hold onto your arm to get balanced. Say:

Script: “You may hold onto my arm while you get in position. When you are ready, let go. Are you ready?”

Say “Ready, begin”, and start timing when the participant lets go.

(If the participant does not hold onto your arm, say “Ready, begin” and start timing when they are in position.)

Say, “STOP” after 10 seconds or when the participant steps out of the position or grabs a support.

If the participant is unable to hold the position for 10 seconds, do not attempt the other balance tests. Record to 0.01 second how long participant is able to hold this position and go to the next clinic exam.

5.7.4. Tandem Stand

The third position evaluated in the balance tests is the tandem position. To assume the tandem position, the heel of one foot is placed directly in front of the toes of the other foot. Either foot can be placed in the forward position. Participants who are unable to hold the tandem stand for less than 10 seconds do not proceed further with the balance tests. Participants who successfully complete the tandem stand proceed to the next balance test. If the participant successfully completed the semi-tandem stand and did not attempt the tandem stand, record the reason on the data collection form.

- a) Describe the position.

Script: “Now I would like you to try to stand with the heel of one foot in front of and touching the toes of the other foot for about 10 seconds. Please watch while I demonstrate.”

- b) Demonstrate and say:

Script: “You may put either foot in front, whichever is more comfortable. You can use your arms and body to maintain your balance. Try to hold your feet in position until I say stop.”

Stand next to the participant to help him into the tandem position. Supply just enough support to the participant’s arm to prevent loss of balance.

- c) Begin the test. Allow the participant to hold onto your arm to get balanced. Say:

Script: “You may hold onto my arm while you get in position. When you are ready, let go. Are you ready?”

Say “Ready, begin”, and start timing when the participant lets go.

(If the participant does not hold onto your arm, say “Ready, begin” and start timing when they are in position.)

Say, “STOP” after 10 seconds or when the participant steps out of the position or grabs a support.

If the participant is unable to hold the position for 10 seconds, do not attempt the one-leg stand. Record to 0.01 second how long participant is able to hold this position and go to the next clinic exam.

5.7.5. One Leg Stand

The final position evaluated in the balance tests is the one-leg stand. To assume the one-leg position, one foot is raised about 2 inches off the floor, with the knee flexed. The foot should be raised in the same plane, and not extended to the front or the back of the participant. The toe on the raised foot does not need to be pointing in a specific direction and can be positioned in a way the participant is most comfortable with. Either leg can be used to stand on.

If the participant successfully completed the tandem stand, but did not attempt the one-leg stand, record the reason on the data collection form.

- a) Describe the position.

Script: “For the last position, I would like you to try to stand on one leg for about 30 seconds. Please watch while I demonstrate.”

- b) Demonstrate the one-leg stand by lifting the opposite leg so that the toes are about 2 inches off the floor. The knee should be flexed. While demonstrating say:

Script: “You may stand on either leg, whichever is more comfortable. You can use your arms and body to maintain your balance, but try not to have your foot, ankle or knee rest against your other leg. Try to hold your foot up until I say stop. If you lose your balance, put your foot down.”

Stand next to the participant to help him into the one-leg stand position. Supply just enough support to the participant’s arm to prevent loss of balance.

- c) Begin the test. Allow the participant to hold onto your arm to get balanced. Say:

Script: “You may hold onto my arm while you get in position. When you are ready, let go. Are you ready?”

Say “Ready, begin”, and start timing when the participant lets go.

(If the participant does not hold onto your arm, say “Ready, begin” and start timing when they are in position.)

Say, “STOP” after 30 seconds or when the participant steps out of the position, grabs a support, or if raised foot, ankle, or knee makes contact with the other leg.

If the participant is unable to hold the position for 30 seconds, record to 0.01 second how long participant is able to hold this position and go to the next clinic exam.

6. **Alert Values/Follow-up/Reporting**

These test results have no alert values and are not reported to the participant or physician.

7. Quality Assurance

7.1 Training and Certification

The examiner requires no special qualifications or experience to perform this assessment. Training should include:

- Read and study manual
- Attend MrOS training session on techniques (or observe administration by experienced examiner)
- Practice on other staff or volunteers
- Discuss problems and questions with local expert or QC officer

7.2 Certification Requirements

- Complete training requirements
- Recite exclusions
- Conduct exam on 2 volunteers:
 - According to protocol, as demonstrated by completed QC checklist
 - Times within ± 1 s of QC officer, step counts agrees with QC officer

7.3 Quality Assurance Checklist

- Performance tests
- Asks participant about problems which might prevent testing
- Correctly assesses impairments/appliances (records lower-extremity orthosis, prosthesis, missing limb, or paralysis, if present)

Chair stands

- Back of chair against a wall
- Script correctly and clearly delivered for each test
- Correctly demonstrates single stand, emphasizing keeping arms tight across chest
- Correctly demonstrates two stands, emphasizing full stand and return to complete sit
- Says “ready, go.” for each test
- Counts each chair stand, and stops timing after participant STANDS UP on fifth stand
- Records and explains unusual values
- If task was not performed, codes and explains reasons

Short walks

Usual pace

- Script correctly and clearly delivered
- Correctly demonstrates
- Toes touching start line
- Timing started coincident with participant’s first footfall
- Correct number of steps counted, and time stopped with first footfall over the finish line
- Repeat (second trial)

Balance Tests

- ❑ Script correctly and clearly delivered
- ❑ Correctly demonstrates each position for the participant
- ❑ Checks that participant's feet are in correct position for each stand
- ❑ Waits for participant's position to stabilize before timing begins
- ❑ Timing started coincident with participant release
- ❑ Timing stopped after 10 seconds for the side-by-side, semi-tandem, and tandem stands; and 30 seconds for the one-leg stand, or when participant takes a step or holds on
- ❑ If task was not performed, codes and records reasons

8. References

1. Ferrucci, Luigi: Unpublished data.