

Chapter 17

Performance Measures

SHORT PHYSICAL PERFORMANCE BATTERY (SPPB)

Background: The SPPB, originally developed for the Established Populations for the Epidemiologic Study of the Elderly (EPESE), is a brief performance battery based on timed short distance walk, repeated chair stands, and a set of balance tests. The SPPB can be used to assess how well older persons perform simple movements that represent the building blocks of daily activities that require good lower extremity function. The information concerning functional ability provided by these tests adds valuable insight to the assessment of the older person. The test takes about 10-15 minutes to administer and can be done in the clinic or the home setting. The battery has an excellent safety record. It has been administered to over 10,000 persons in various studies and no serious injuries are known to have occurred.

Equipment: The following equipment is required for the SPPB:

- Stopwatch
- Masking tape
- Chain with fine links measuring just over 4 meters (approximately) in length (for home or off-site administration)
- Script
- Score sheet
- Straight-backed chair with a hard seat, standard for all sites

Procedures: A CD-ROM that provides complete instructions for the administration of the SPPB has been provided to each field center for training and recertification.

Overview of SPPB: During all of the tests, safety of the participants is paramount. Participants who do not feel safe or who are unable to perform a test should not be pressed. All procedures should be clearly demonstrated to the participants prior to performing any test and they should be queried to ensure that they understand the instructions. If it is obvious that the participant has not understood the directions, you may reread the standard instructions, but you should not reword them. Remember that you will be demonstrating each maneuver and that someone who may not completely understand the verbal instructions may still be able to perform the test following the demonstration. These tests have been successfully used in persons with cognitive impairment. To optimize the participant's understanding, go through the instructions slowly while making sure that the participant is paying attention.

You should be completely familiar with all of the test procedures and practice them before attempting to administer the test battery to a participant. After watching the procedures on the training CD-ROM several times, you should practice administering the battery with a partner who is in training or trained, or practice with a volunteer under the observation of a partner or someone experienced in administering the battery. When practicing, the person who is acting as the participant should role-play different levels of physical limitation to give the new examiner experience with people who have difficulty with the tests. Also, be sure to practice on some older volunteers, including fully filling out the score sheets. After practicing several times, go back and watch the CD-ROM again. To ensure reproducibility, it is imperative that all participants are given the same instructions and that quantitative measurements associated with the tests are made in a uniform manner. You should not develop your own way of giving instructions. The instructions can be memorized or read but since some of them are fairly long, you may want to read them from the sheet during the test. There are certain parts of the assessment where it is awkward to try to read the instructions

and simultaneously demonstrate or administer the test. These portions of the instructions must be memorized.

The SPPB consists of three types of physical maneuvers: the balance tests, the gait speed test, and the chair stand test. The tests are always performed in this order. Each of these three maneuvers is scored separately by the examiner. While the actual performance times can be used to evaluate specific functional abilities, it has also proven useful to classify performance into categories and provide a numerical score. The scores from each of the tests can then be added together to obtain an aggregate or summary score for each participant. Inability to perform any individual component of the battery results in a score of 0, while completion of the maneuver results in a score of 1 to 4. The maximum aggregate score is therefore 12.

If a specific maneuver is not attempted, you should explain why no attempt was made. Select one of the options on the score sheet. It is critical but sometimes very difficult to distinguish between someone who is unable and therefore unwilling to try a test and a person who simply refuses to do the test because they are not interested in participating. This is a judgment that rests with the examiner. If someone refuses to participate in any of these tests, you would generally mark that they had refused on the answer sheet unless it is quite clear that they are refusing because they just can't do the test or are afraid to attempt it. Refusals are considered missing data and this person will not contribute to the research or clinical evaluation being performed. A participant who is unable to perform the test is scored zero for the particular test. Knowing someone is unable to perform the test is valuable information. If a person is unable to perform a test because they cannot follow the instructions, please mark that option for each of the maneuvers.

Balance Tests:

Overview: The tests of balance provide an assessment of the participant's ability to hold three basic standing positions with the eyes open. No equipment other than a stopwatch, script, and score sheet is needed.

The three positions are side-by-side stand, semi-tandem stand, and full tandem stand (or heel-to-toe) and are performed in this order. 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. Each test is timed and the participant is allowed only one chance to maintain each position.

For each position, the examiner first describes and then demonstrates the appropriate stand. The participant then assumes the correct foot position while supported by the examiner. Once the participant appears to be steady, ask if he or she is ready. When they say yes, the examiner relinquishes support, says "Ready, begin," and starts timing. The timing is continued until the participant moves his or her feet, grasps the examiner for support, or 10 seconds have elapsed. Record any time less than 10 seconds to the nearest hundredth of a second.

You may stabilize the participant by lightly holding their arm until their feet are in the correct position. Many people will need little support to help them into position but others will need strong support until they are in position and steady. Wait until they feel steady before moving on to the next step. If you cannot steady them with support, then do not try the maneuver. Code it as "not attempted" and then circle "Not attempted, you felt unsafe." This applies to all three balance tests. If participant does not attempt or refuses balance tests, proceed to Gait Speed.

Make sure that the participant is stable and that their feet are in the correct position before you release them. Have the stopwatch ready to begin timing as soon as you release their arm. During this and all other

balance tests, the examiner should stand next to the participant as they gets 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. It is suggested that the examiner stand at the participant's side and have his/her arms outstretched in front of and behind the participant's trunk

It's not important to stop the clock and the test at exactly 10 seconds. The time does not have to be measured exactly if the participant holds the position for more than 10 seconds. Don't watch the stopwatch continuously during the test. Watch the participant and be prepared to stop the watch if the participant steps out of position or grabs your arm. Glance at the watch occasionally to see if the position has been held for 10 seconds.

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 and are given a score of 0 for this portion of the battery. Participants who successfully complete the side-by-side test receive 1 point and proceed to the semi-tandem balance test. Note: Scoring for this item will be computer generated.

Stabilize the participant by lightly holding their arm until their feet are in the correct position. Make sure that the participant is stable and that their feet are in the correct position before you release them. Have the stopwatch ready to begin timing as soon as you release their arm. Stay close to the participant so they can grab your arm if they lose their balance but not so close that they can't use their arms for balance.

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 successfully hold the semi-tandem position for 10 seconds are given 1 additional point and proceed to the final balance test. Those who fail to hold the position for 10 seconds receive no points and do not perform the tandem balance test. Note: Scoring for this item will be computer generated.

Stabilize the participant by lightly holding their arm until their feet are in the correct position. Make sure that the participant is stable and that their feet are in the correct position before you release them. Have the stopwatch ready to begin timing as soon as you release their arm. Stay close to the participant so they can grab your arm if they lose their balance but not so close that they can't use their arms for balance.

Tandem Stand: The final 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 hold this position for 10 seconds are awarded 2 additional points. Those who hold the position for 3 to 9.99 seconds are given 1 additional point. Holding the position for less than 3 seconds results in no points. Note: Scoring for this battery will be computer generated.

Stabilize the participant by lightly holding their arm until their feet are in the correct position. Make sure that the participant is stable and that their feet are in the correct position before you release them. Have the stopwatch ready to begin timing as soon as you release their arm. Stay close to the participant so they can grab your arm if they lose their balance but not so close that they can't use their arms for balance.

Gait Speed Test:

In this test, the participant's ability to walk 4 meters is assessed. You will need a stopwatch and a marked walking course. If this test is being done in a new location, then a course must be laid out on the floor.

The walking course should be unobstructed and include at least an extra one-half meter on each end. Participants are instructed to walk at their usual speed, and timing is stopped when the first foot completely crosses the 4-meter mark. The faster of two timed walks is used for scoring purposes. When training to perform this test, it is good practice to have two or more people doing the timing so that timing can be compared for precision.

A cane or walker may be used during the walk, but if people with such devices can walk short distances without them, they should be encouraged to do so. Many people with assistive devices use them only when they walk outdoors or for long distances indoors. Doing the test without the device provides a much more accurate assessment of the functional limitations of the participant. Ask the participant if she ever walks at home without the device. Then ask the participant if they think that they can walk a short distance for the test. Participants who normally use assistive devices should be watched particularly closely during the test to prevent falling.

If possible, women wearing high heels should change into another pair of shoes before performing the gait speed test. Press the start/stop button to start the stopwatch when the participant steps over the starting line. Wait until the participant actually begins to move before starting the watch. Do not start the watch when you say "begin."

The position of the examiner is critical for the walk. If you are too close you will set the pace. If you are too far behind you will not be in a good position if the participant falls. You also need to be in a good position to observe the foot crossing the finish line. The best position to maintain during the walk is to the side and slightly behind, outside of the participant's visual field. Record the time when the participant's first foot completely crosses the 4-meter line. If the foot lands on the line but doesn't cross it, this is not the end of the test. You need to anticipate when a foot will fully cross the line and be ready to stop the watch as it crosses the line. You should imagine a plane of glass at the finish line that the foot breaks when it crosses. This is the time to stop the watch. Record the time to the nearest hundredth of a second.

If you have trouble with the stopwatch or you think that the timing wasn't accurate, the gait speed test should be repeated.

Scoring of the gait speed test is based on established categories of completion times that were previously shown to divide the older population into four equal groups. Participants who require more than 8.70 seconds to complete the walk receive 1 point; participants whose completion times fall in the range of 6.21-8.70 seconds receive 2 points; participants who finish in 4.82-6.20 seconds receive 3 points. Participants who finish the walk in less than 4.82 seconds receive the full 4 points. Inability to complete the walk in less than 60 seconds results in a score of 0. If the walk was not attempted or not completed, you should select a reason from the options on the score sheet. Note: Scoring for this battery will be computer generated.

Although 4 meters is the preferred walk distance, an alternate walk distance of 3 meters can be used in those areas (for example, some home settings) where an unobstructed course of 4 meters is not available. Quartiles of completion times and associated scores for the 3-meter course are shown on the score sheet.

Chair Stand Test:

The final portion of the SPPB is the chair stand test. In this test, participants are first instructed to fold their arms across their chest and to try to stand up one time from an armless chair placed against a wall. To perform this test you will need a stopwatch, the script, a score sheet, and a straight-backed chair with a hard seat. If this type of chair is not available, a chair with a softer seat or a chair with arms may be substituted.

If the participant is successful rising from the chair once, they are then asked to stand up and sit down 5 times as quickly as possible. Timing begins as soon as the command to stand is given and continues until the participant straightens at the end of the fifth stand. When learning to do this, it is useful for two or more people to time the test so that the times can be compared for precision.

For efficiency, it is valuable to have two chairs available so that the examiner can do the demonstration while the participant sits in the other chair and watches. If only one chair is available then the participant will have to get up to watch the demonstrations.

To ensure safety, the examiner should stand in front of the participant and be prepared to catch them if they fall forward. However, do not stand so close that the participant feels hemmed in and slows their pace during the chair stands.

For the first portion of the test, simply record whether the participant was able to rise from the chair without the use of their arms. If the participant is unsuccessful, the examiner should ask the participant to try to stand using their arms. Inability to complete the single chair stand with arms folded or being able to do it only with use of the arms ends the chair stand test and results in a score of zero for this portion of the battery. Record in Q20 the reason the participant did not attempt this test.

For the second portion of the test (multiple chair stands), instruct the participant to stand up straight as quickly as they can five times without stopping in between. After standing up each time, the participant must sit down and then stand up again, keeping their arms folded across their chest. Emphasize the word "quickly" and perform the demonstration quickly to further reinforce this point. The gait speed test is done at normal speed but the chair stand test should be done as quickly as possible. Count the stand number only after the participant has straightened up. Do not pace the test with your counting. If the participant does not stand up completely, stop the test and demonstrate a second time.

Timing begins when the command to stand is given and continues until the participant straightens their body at the end of the fifth rise. This contrasts with the gait speed test where timing begins only when the participant begins to move. During the test, count out loud as the participant rises up to five times. Do not coach or encourage the participant during the test. Watch the participant closely and stop the test if the participant is tired or short of breath during the repeated chair stands. The test should be stopped if the participant has to use their arms to rise at any time or if the participant has not completed the five chair rises after one minute. You should also stop the test at your discretion if, for any reason, you are concerned about the participant's safety. If the participant stops before completing the five rises, you should ask them if they can continue. If the participant says yes, continue timing. If the participant says no, stop the test. If participant does not attempt or complete this test, indicate the reason why in Q23.

Scoring of the chair stand test is based on established categories of completion times of five repetitions that have been shown to divide the older population into four equal groups. Participants who require more than 16.70 but less than 60 seconds receive 1 point. Participants whose completion times fall in the range 13.70-16.69 seconds receive 2 points, while those in the range 11.20-13.69 seconds receive 3 points. Participants who finish the 5 repetitions in less than 11.20 seconds receive the full 4 points. Note: Scoring for this battery will be computer generated.

Summary of Scoring:

The composite score for the SPPB is simply the sum of the scores of the three individual components. The maximum score that a participant can receive is 12 points. The SPPB score will be computer generated in this study. It will be scored by the computer.

GRIP STRENGTH

Background: Muscle strength is an indicator of muscle function and therefore an important outcome of this study. Fiatarone et al. have postulated that strength is a more important limiting factor than cardiovascular endurance in the ability of older individuals to maintain an independent lifestyle. Muscle strength decreases with age but little is known about the influence of changes in muscle mass, fat mass, and physical activity on this decrease. Grip strength is a commonly used measure of upper body skeletal muscle function and has been widely used as a general indicator of frailty. Grip strength in the strongest hand is measured using an adjustable, hydraulic grip strength dynamometer, which registers maximum kilograms of force during a trial, with an adjustable handgrip.

Equipment:

- Jamar Hydraulic Hand Dynamometer
- Standard chair

Use and Maintenance: For routine maintenance, follow the instructions in the Jamar Dynamometer Owner's Manual.

To Use the Dynamometer:

1. Please remember that it is a precision instrument and its accuracy can be impaired by abuse. Never force the handles or subject the instrument to unnecessary impact.
2. Set the adjustable handle to the desired spacing. (Before moving the handle from one position to another, note that the handle clip is located at the lower (furthest) post from the gauge). Positioning of the handle is very important. If the handle is not replaced in the correct position, the readings will not be accurate. The Jamar Dynamometer has 5 settings (Small – XX-Large). The most frequently used setting in this study is supposed to be position '2' from the inside, depending on the size of participant's hand.
3. Rotate the red peak-hold needle counter-clockwise to 0. Always look straight ahead at the dial when reading.
4. After the participant has used the instrument, reset the peak-hold needle to zero before attempting a new reading.

Service Tips: To make sure the instrument is reading accurately, it's a good idea to make a few checks each month, as listed below. If you detect a problem, report this to the quality control (QC) officer.

Posts: Remove the adjustable handle and check that each post moves up and down freely (through a very small distance, about 1/8") within the plastic aperture (the guide) even when you exert pressure on the side of the post. About once a year, place a small amount of grease on the two guides. If excessive friction exists between the post and guide, return the dynamometer to the QC officer.

Hydraulics: To check the hydraulic mechanism, first remove the adjustable handle. While watching the top post, push down on the bottom post. Normally, both posts should move about 1/8", with top and bottom posts moving in opposite directions. Movement less than 1/16" indicates a probable leak in the

hydraulic system, which requires service. Return the dynamometer to the QC officer.

Handle: Grasp the instrument normally and look carefully at the way the forks of the adjustable handle are supported on the posts. Each fork should touch the post at approximately its mid-point. If this is not the case, return the instrument to your supervisor.

Peak-Hold Needle: Check for excessive friction in the peak-hold assembly by turning the peak-hold knob counter-clockwise. If the peak-hold needle causes the gauge needle to move, return the gauge for service.

If the peak hold needle is knocked off its support pin, it can readily be repositioned. Unscrew the crystal and turn it upside down. Locate the brass pin in the center of the crystal (the pin is part of the chrome knob on the outside of the crystal). Locate the slot on the brass pin and place the peak-hold needle into this slot.

Calibration Check: Every month: Check the calibration of the grip strength dynamometer by hanging 5 kg and 20 kg (or 10 and 50 lb) weights across the handle using two Velcro straps, one strap on each side of the dynamometer handle, or one wide strap that covers the whole handle. Lift the weights slowly from the floor while they are strapped to the dynamometer handle and record the maximum kilograms registered. The lifting motion should be very slow and smooth, and the weight should remain evenly distributed between the two sides of the handle. Repeat the procedure three times and record each result.

Average the three calibration trials. The dynamometer should be accurate within ± 2 kgs for the average of the three calibration trials. If the calibration check is not within these limits, notify the QC officer. It may be necessary to send the dynamometer to the manufacturer for repair and recalibration. DO NOT attempt to recalibrate the dynamometer yourself. Calibration problems can be caused by dropping the dynamometer or by leaks in the hydraulic system.

Safety Issues and Exclusions: This test should not be performed in the affected hand if the participant:

- Has a current flare-up of pain in their wrist or hand; for example arthritis or tendonitis.
- Has undergone fusion, arthroplasty, tendon repair, synovectomy, or other related surgery of the upper extremity in the past 3 months.
- If only one side is affected, test the unaffected side.

Method: The participant should be seated in a standard chair. Grip strength will be measured in two trials of the stronger hand (unless there are extenuating circumstances - see above about safety).

Script: *"In this exercise, I am going to use this instrument to measure the strength in your hand. I am going to ask you some questions to determine which hand would be better to test."*

Question 24:

- Determine if the participant is right or left handed.
- Script: *"Are you right or left handed?"*
- If ambidextrous then mark "Both".
- Record answer on form.

Question 25:

- Determine which hand is stronger.
- **Script:** *"Which is your stronger hand?"*

If the right hand is stronger, test this hand. If the left hand is the stronger hand, test that hand – but after having determined the safety of testing either hand as follows in Q26 and 27.

Question 26a:

- Determine if the participant has severe pain or severe arthritis in his/her hand.
- Script: *"Do you have severe pain or severe arthritis in your right hand?"*
- Record answer on form and proceed to Q26b.

Question 26b:

- Script: *"Have you had surgery on your right hand or wrist in the past three months?"*
- Record answer on form and proceed to Q26c.

Question 26c:

- Script: *"Do you think you could safely squeeze this with your right hand, as hard as you can?"*
- Record answer on form.
- If yes; Go to Q28 for the test. If no; do not test right hand, Go to Q27a to evaluate left hand.

Question 27a:

- Script: *"Do you have severe pain or severe arthritis in your left hand?"*
- Record answer on form and proceed to Q27b

Question 27b:

- Script: *"Have you had surgery on your left hand or wrist in the past three months?"*
- Record answer on form and proceed to Q27c.

Question 27c:

- Script: *"Do you think you could safely squeeze this with your left hand, as hard as you can?"*
- Record answer on form.
- If yes; go to Q28 for the test. If no; do not test left hand and go to Q26a to evaluate right hand if you have not already done so. If neither left nor right hand is eligible, record the information in Q28 and END TEST.
- If the participant reports both hands to have the same level of strength, test the dominant hand indicated in Q25.
- If neither dominant - test right hand.
- Record answer on form in Q28.

Question 28:

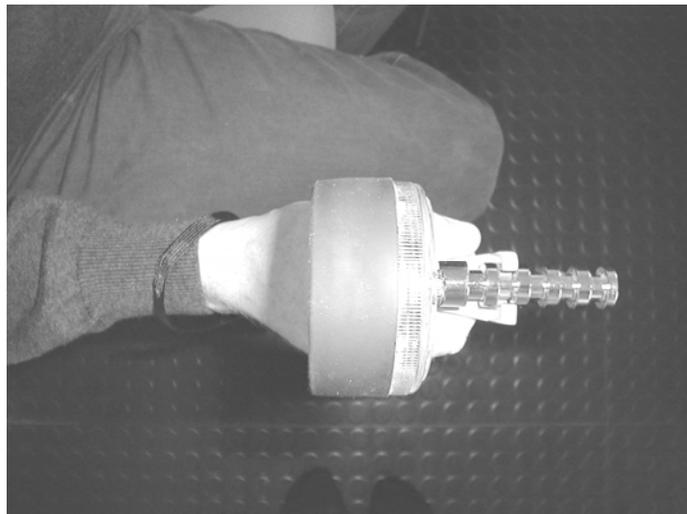
- Record on the form which hand was tested. If neither is tested, mark the form as such and end the test.

Demonstration and Practice:

The examination is done with the participant sitting comfortably in his/her chair.

- Set the adjustable handle in the desired spacing (standard is position '2' from inside).
- Let the participant comfortable arrange the instrument in his/her hand.
- The dynamometer is held in the hand, which is to be tested.
- Have the participant sit with their shoulder adducted and neutrally rotated.
- Elbow flexed at 90°, forearm flexed in neutral position and wrist between 0° and 30° and between 0° and 15° ulnar deviation (see photographs).

Demonstrate the correct grip and arm position. As you demonstrate, instruct the participant to squeeze the hand maximally. Allow one sub maximal practice trial to determine if the procedure is understood by the participant.



- **Script:** *"I'd like you to sit down and take your right/left arm and please place it next to your body and bend your elbow at a 90° angle. Grip the two bars in your hand, like this. You need to slowly squeeze the bars as hard as you can."*
- **Script:** *"Now try it once just to get the feel of it. For this practice, just squeeze gently. It won't feel like the bars are moving, but your strength will be recorded. Are the bars the right distance apart for a comfortable grip?"* Show dial to participant. Adjust the handgrip again, if necessary.

Test Grip:

- Mark dynamometer setting in Q29.
- Script: *"We'll do this twice. This time it counts, so when I say "Squeeze", squeeze as hard as you can. Ready? Squeeze! Squeeze! Squeeze! Okay now, STOP."*
- Have the participant perform the test. Set the dynamometer to zero prior to each attempt: Record the kilograms pulled from the dial to the nearest 2 kilograms in Q30. Reset the dial to "0" after each trial. If unable to test/excluded or refused mark the appropriate box in Q30.
- Perform two trials with 10 seconds rest in between.
- Script: *"Now, one more time. Squeeze as hard as you can. Ready? Squeeze! Squeeze! Squeeze! Okay now, STOP."*
- Record results for Trial 2 in Q31 as instructed for Trial 1 above.
- When the test is completed tell the participant how many kilograms or pounds were read on the dial and that they did just fine.
- Record maximum kilograms for the tested hand on participant's results form.
- If the participant is unable to complete the test because they were unable to understand the instructions, then mark the appropriate box for both Questions 30 and 31.

Study Documents Referred to in this Chapter:

- Performance Measures Data Collection Form