

SITTING HEIGHT

1. Background and Rationale

Measures of torso and leg length are assessments of stature. Leg length is estimated by subtracting sitting height from standing height.^{1,2} Stature appears to be sensitive to childhood environment. For example, recent epidemiologic observations suggest that adult leg length but not torso length is strongly correlated with higher socioeconomic and better nutritional status during infancy.¹ Furthermore, men with long legs relative to height have a more favorable cardiovascular risk profile than men with short legs relative to height.² These data suggest that long bone growth reflects long-lasting effects of childhood environment³ or the synergy of genetic predisposition and environment. Thus, in studies of the relation of oral and skeletal bone loss among older men, we will examine the whether leg or torso lengths (or ratios of these measures to height) are determinants of skeletal and oral bone loss. In addition, we will examine the correlation between measured femoral length from DXA and estimated leg length.

2. Equipment and Supplies

- Harpenden stadiometer
- 0.5 kg weight
- Clear plastic right angle or T-square
- Stool without wheels and with a flat unpadded seat and without arms (the "Benjamin" style stool from IKEA)
- Non-skid surface on the bottom of each leg
- Adhesive dots or tape that can be placed on the floor under the stadiometer to indicate the placement of the stool for the measurement of sitting height.

The stadiometer produced by Holtain Ltd. - known as the "Harpenden" stadiometer because of its development during the Harpenden Longitudinal Growth Study - is a counter recording instrument. The counter gives a reading in millimeters over a range of 600 mm to 2,100 mm. It is a wall-mounted instrument made of light alloy with a wooden headboard fixed to a metal carriage that moves freely on ball bearing rollers.

Place a weight, of about 0.5 kg, on the headboard to standardize pressure on the head and improve measurement performance. A soft weight, such as a bean bag, should be used to avoid injury to the participant if it should fall off.

Measure the height of the stool from the floor to the top deck of the seat with the stadiometer. Record the height of the stool to the nearest millimeter (mm). If the stadiometer does not move low enough to measure the height of the chair, a standard tape measure may be used instead. The height of the chair should be measured monthly and recorded on a calibration log.

2.1 Stadiometer Use and Maintenance

- The counter may break if the headboard is 'raced' up or down the backboard. The headboard should therefore be moved to its topmost position when not in use.

- The stadiometer contains a direct reading counter mounted on a counter-balanced carriage riding on ball bearings. The counter is a self-contained unit and requires no maintenance. A spare counter is provided if replacement should be required.
- The bearings and counter weight pulleys should be lubricated semiannually with one drop of light machine or instrument oil.
- The "formica" covering may be washed with soap and water as required.

2.2 Stadiometer Calibration

Daily. A metal rod of 600 mm length is placed between the headboard and the floor so that it stands vertically. If the counter does not record the correct length of the rod, loosen it by undoing the two metal retaining screws, and pull the counter away from the main fiber cog of the carriage. In this position, turn the small metal cog of the counter until the counter records the true length of the metal rod. Press the counter against the backplate so that the teeth of the counter cog and the carriage cog engage, and tighten the retaining screws. Move the headboard up and down the backboard a number of times to ensure that the counter continues to give an accurate reading. If not, replace the counter.

3. Safety Issues and Exclusions

The measurement of sitting height with the wall-mounted stadiometer should not pose any safety problems to the study participants provided that the participant can sit independently with their hands resting on top of the thighs. The recorder should hold the stool while the participant is being seated, so that the stool does not slide away from him. The bottom of the legs should be covered with skid-resistant material in order to prevent the stool from sliding around. After each measure it is important to move the horizontal bar up as far away from the participant's head as possible, so he does not hit his head when he stands.

4. Participant and Exam Room Preparation

The participant should be relaxed and sitting upright in the stool, with his feet flat on the floor in front of him if possible, and his legs relaxed.

Ask the participant to remove any hairpiece or rearrange any hair styling that might interfere with firm contact between the headboard and the scalp.

The stadiometer should be mounted on a straight wall that is at a true 90° angle to the floor. The heel plate should be mounted on the floor in the same vertical plane as the backboard of the stadiometer. The floor should be level and free of carpeting. If bare floor is unavailable, firm, non-compressible carpeting (e.g., indoor-outdoor) is acceptable. There should be about a foot or more of unoccupied wall space on either side of the stadiometer.

5. Measurement Procedures

5.1 General Measurement Issues

The participant should be facing away from the stadiometer when he sits in the stool (that is, his back should be near the “formica” as it is with the standing measure. The back of the stool should not touch the “formica” surface.

Before the clinic visits begin, place marks on the floor using adhesive dots or tape that mark the placement of the stool for the sitting height measure. Choose a color for the dots or tape that contrasts strongly with the color of the floor. Place the dots or tape on the floor in such a manner that each stool leg will rest over a dot or piece of tape, and the stool can be lined up under the stadiometer in the same way each time. The back of the stool’s legs should line up horizontally with the wall plate (the same way as a participant’s heels line up), but should not touch the wall plate.

To perform this measurement accurately, it is important that the recorder observe the position of both the participant while he is sitting and the stadiometer. The participant should be instructed to avoid slouching when sitting in the stool, by keeping his hips pushed as far back on the seat deck as possible and keeping his back straight by ‘sitting tall’. His back should touch the stadiometer. If possible, his feet should rest firmly on the floor and his knees should be about 6 inches apart. As with the standing height measure, the stadiometer should be brought down in the midline of the head.

5.2 Administration

After standing height is measured, place the stool so that all the legs are aligned correctly on the dots or tape marks on the floor. Make sure the back of the stool does not touch the wall plate.

Script: “Now, we are going to measure your height while you are sitting.”

2) Have the participant sit in the stool. Ask him to push himself back completely in the stool so that his hips line up with the back of the stool and to straighten his back by sitting tall. His back should be touching the stadiometer. He should place his feet firmly on the floor in front of the stool keeping a small space between his knees. Ask him to place his palms face down on top of his thighs, so his arms are relaxed. The position should be a comfortable sitting position. His head will not be flat against the wall as it would be when he is standing. However, his head should remain in the Frankfort Horizontal Plane, as with the standing height measure.

Hold the stool to make sure it does not move while the man seats himself. If the stool has moved from the positions marked on the floor, ask him to please stand, then reposition the stool and ask him to sit again.

Script: "Please sit down in this stool. Sit back as far as possible and place your feet flat on the floor. Keep your feet and knees apart just a little – about 6 inches between your knees. Look straight ahead and sit tall. (Optional: I will position your head so that I can measure your sitting height more accurately.)"

3) Bring the horizontal bar down firmly onto the top of the head. Place the weight on the headboard.

(Optional: To ensure that the Frankfort Plane has been achieved, the examiner may find it helpful to grip the head with open hands and pivot it gently backwards and forwards while observing the counter. The counter should register the greatest height when the head is tilted not too far forward or backwards. It is a relatively easy matter to ensure correct positioning.)

4) Have the participant breathe in deeply. He should not rise from his sitting position while taking a deep breath.

Script: "Take a deep breath."

5) Record the reading on the stadiometer just before the participant exhales.

Script: "Breathe out."

6) Move the horizontal bar up away from the participant's head, so he does not hit it when he stands up.

7) Ask the participant to stand.

Script: "Please stand up from the stool for a moment. We will take this measure one more time."

8) Repeat steps 2-5 and take a second measurement. Repeat step 6.

If the two measurements differ by ≥ 4 mm, take an additional two measurements.

Deviations and exceptions to standard positioning

Kyphosis—Proceed as for the standing height measure. If the spinal curvature is severe, have the participant press the part of the spine that protrudes the farthest to the back of the stool.

If the participant is severely kyphotic turn the stool sideways, so that it is easy for him to sit in the stool. One shoulder should be pressed to the wall plate (formica). Check to make sure that the head is in the Frankfort position. Record that the participant was measured sitting sideways due to kyphosis.

7. Quality Assurance

7.1 Training Requirements

The technician requires no special qualifications for performing this assessment. The training should include:

- Read and study manual
- Attend Mr.OS training session on techniques (or observe administration by experienced examiner)
- Practice on other staff or volunteers with a special emphasis on heavy participants and men with kyphotic posture and compare measurements with those made by an experienced colleague (Goal: keep differences in repeat measurements and between examiners to less than 4 mm)
- Discuss problems and questions with local expert or QC officer

7.2 Certification Requirements

- Complete training requirements
- Demonstrate calibration check procedures for stadiometer
- Conduct exam on 2 volunteers:
 - According to protocol, as demonstrated by completed QC checklist
 - Differences between repeat measures should be less than 4 mm
- Differences between trainees and QC officer's measurements should be less than 4 mm

7.3 Quality Assurance Checklist

- 0.5 kg weight on stadiometer
- Hairpiece removed, hair style altered, if necessary
- Check that stool is placed correctly on the marks on the floor and the back is not touching the stadiometer.
- Checks that participant is seated correctly: sitting back as far as possible, feet are flat on the floor, feet and heels are about 6 inches apart, back is straight against the stadiometer
- Check that the participant is looking straight ahead (or aligns the head if necessary)
- Check that the horizontal bar is moved up away from the participant's head so he can stand without hitting it.
- Two or more measurements made if first two differ by ≥ 4 mm

¹ Wadsworth MEJ, Hardy RJ, Paul AA, Marshall SF, Cole TJ. Leg and trunk length at 43 years in relation to childhood health, diet and family circumstances; evidence from the 1946 birth cohort. *Int J Epidemiol* 2002;31:383-390.

² Davey Smith G, Greenwood, Gunnell D, Sweetnam P, Yarnell J, Elwood P. Leg length, insulin resistance, and coronary heart disease risk. *J Epidemiol Community Health* 2001;55:867-872.

³ Gunnell D. Commentary: Can adult anthropometry be used as a 'biomarker' for prenatal and childhood exposures? *Int J Epidemiol* 2002;31:390-394.