

STANDING AND SITTING HEIGHTS

1. Background and Rationale

1.1 Standing height. The measurement of stature (standing height) will be used to address three main questions. First, is height loss associated with a decline in physical function? Second, is height loss related to the risk of weight-related disease, disability or mortality? Third, how well does body mass index ($\text{weight}/\text{stature}^2$) approximate total body fatness in the elderly? Standing height is measured in millimeters with a wall-mounted Harpenden stadiometer.

1.2 Sitting height. Sitting height is a measure of the upper segment of the body including the trunk, neck, and head heights. The difference between sitting height and standing height offers an accurate estimate of leg length, or subischial height. Because the hip joint is difficult to locate precisely, this estimation proves much easier than a direct measurement of leg length.¹⁻⁶

Leg length is an important measure of the Health ABC study for at least two reasons. First, it is a predictor of appendicular muscle mass. Second, racial differences in leg length may be related to differences in muscle mass. It has been observed that blacks have relatively longer extremities compared to whites. Therefore, their longer extremities might explain their greater appendicular skeletal mass. Gallagher has shown that relative leg length was an additional predictor of appendicular muscle mass determined by DXA in a population of black and white women, even after adjusting for weight, height, sex, and age.

A third reason for measuring sitting height includes its usefulness in the interpretation of pulmonary function tests. Although standing height is conventionally used in clinical settings, in research settings it is suspected that sitting height may provide a more accurate estimate of thorax size.

Sitting height is determined by measuring the distance from the sitting surface to the top of the head using a wall-mounted Harpenden stadiometer and a seat sufficiently high so that the participant's thighs are in horizontal position. Body weight should be on the buttocks and not (partly) on the feet.

2. Equipment and Supplies

- Harpenden stadiometer
- 0.5 kg weight
- Hard, flat-surfaced seat, 25" high with depth of standard chair

- Clear plastic right angle or T-square

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.

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 standing height with the wall-mounted stadiometer should not pose any safety problems to the study participants, provided that they can stand independently. Neither should the measurement of sitting height, provided that the participant can sit independently with hands crossed at the thighs.

4. Participant and Exam Room Preparation

The participant should be relaxed, barefoot or wearing thin socks or stockings.

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 back board 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.

For sitting height, place a sturdy, flat-seated seat, approximately 25" high, in front of the wall-mounted Harpenden stadiometer. The sitting surface centered and placed against the backboard of the stadiometer.

Always use the designated seat. If not possible you will need to measure (using the stadiometer) and record the exact height, in mm, of the seat used.

5. Measurement Procedures

5.1 General Issues

To perform this measurement accurately, it is important that the recorder observe both the position of the participant and of the stadiometer. The participant should be instructed to avoid slouching and the stadiometer brought down in the midline of the head.

5.2 Administration

5.2.1 Standing height

1) Have the participant stand with their back against the wall-mounted stadiometer, heels together. The back (scapulae), buttocks and both heels should be touching the wall-plate. Note: the participant should be standing with head erect and in the Frankfort horizontal plane (see below), but, in general, the back of the head does not need to be in contact with the wall-plate.

Check that the participant is in the correct position, starting with the heels and checking each point of contact with the wall-plate.

Check that the arms are relaxed and hanging loosely at the sides and that the shoulders are relaxed by running your hands over them and feeling the relaxed trapezius muscle.

The head should be in the "Frankfort Horizontal Plane" in which the lowest point on the inferior orbital margin (orbitale) and the upper margin of the external auditory meatus (tragion) form a horizontal line (Figure 1). To verify that the head is in the Frankfort plane, hold the base of a clear plastic right angle (or T of a T-square) against the wall and make sure that the edge perpendicular to the wall is parallel to the "Frankfort Horizontal Plane".

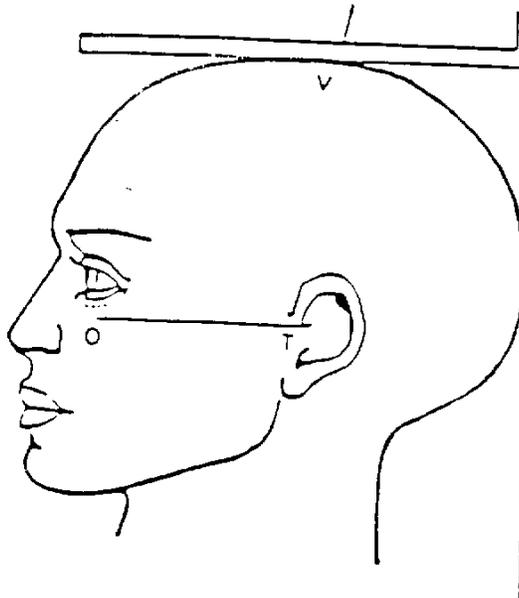


Figure 1.

Orbitale: Lower margin of eye socket

Tragion: Notch above tragus of ear

Frankfort plane: Orbitale-tragion line horizontal

Be sure that the participant maintains the correct posture during the measurement.

Script: "Please stand with your back against the board mounted on this wall. Your legs should be together and both heels, your buttocks and back should be touching the wall-plate. Look straight ahead and stand tall. (Optional: I will position your head so that I can measure your height more accurately.)"

2) Bring the horizontal bar down firmly onto the top of the head. (Place a weight, of about 0.5 kg, on the headboard. This weight presses down on the hair, thus flattening any hairstyle, and overcomes the natural friction of the machine so that any upward or downward movement during the measurement is recorded on the counter.) It may also be necessary, upon occasion, to alter the hair styling of some of the participants for the horizontal bar to make contact with the top of the scalp.

(Optional: To ensure that the Frankfort Plane has been achieved the examiner may find it helpful to grip the head with their 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.)

3) Have the participant breathe in deeply. They should not alter their position by, for example, raising the heels off the floor as they breathe in.

Script: "Take a deep breath."

Record the measurement

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

Script: "Breathe out."

5) Have the participant step away from the stadiometer, then step back in to the measurement position. Repeat steps 1 - 4 and take a second measurement.

6) If the two measurements differ by ϵ 4 mm, take an additional two measurements.

7) A chart converting millimeters to inches should be mounted near the stadiometer so that the participant can be told their height in inches (and centimeters).

Deviations and exceptions to standard positioning:

Obese participants and those with a kyphotic posture may not be able to place the heels, buttocks, and scapulae in a single vertical plane while maintaining a reasonable natural

stance. These participants may be positioned so that only the buttocks, and possibly the scapula, are in contact with the wall-plate. The essential point is that the participant stand erect with the buttocks in contact with the wall plate and the legs as close together as possible. In very obese participants, if it is not possible to obtain contact between the headboard and the top of the skull, then the participant may need to lean back slightly (without tilting the head) until proper contact can be made.

For participants with severe spinal curvature, if the spine is the part that protrudes the farthest, then that should be the part that is touching the wall plate, together with heels and buttocks.

For participants with extreme kyphotic posture, it may not be possible to obtain contact between the headboard and scalp when the participant's back is against the wall-plate. In this case, measure height with the participant standing sideways (side of arm and shoulder in contact with the wall-plate) and positioned so that the headboard contacts the scalp. The head should be in the Frankfurt Horizontal Plane. Record that the participant was measured in the sideways position on the scoring form so that follow-up measurements will be made in the same position.

If the participant has 'knock-knees' then have them separate the heels so that the knees are in contact but do not overlap. Obese participants may also not be able to stand comfortably with the heels touching and may stand with the legs together and the heels separated.

5.2.2 Sitting height

1) Have the participant sit on the seat with the legs hanging unsupported over the edge and with the hands resting on the thighs in a cross-handed position. If the feet are touching the floor, weight should be on the buttocks and not the feet. If the participant is uncomfortable in this position, ie., feels that they are slipping forward, they can rest their feet on the rungs of the seat, again, with their weight on the buttocks and not on the feet. The knees should be directed straight ahead, and the back of the knees should be near the edge of the seat but not in contact with it. The muscles of the thighs and buttocks should be relaxed.

Script: "Please sit on this seat with your knees facing forward. Place your hands on your thighs in a cross-handed position. Sit up as straight as possible with your buttocks and back touching the backboard. (Optional: Do not support your body weight on your feet. All your weight should be on the buttocks.) Relax the muscles of your legs and buttocks."

2) Ask the participant to sit as erect as possible with the buttocks, spine, and back of the head against the stadiometer.

3) The participant should face straight ahead with their head in the Frankfort position (see Figure 1).

4) Place the horizontal bar firmly on the top of the head. (Place a weight, of about 0.5 kg, on the headboard. This weight presses down on the hair, thus flattening any hairstyle and overcomes the natural friction of the machine so that any upward or downward movement during the measurement is recorded on the counter).

Have the participant breathe in deeply.

Script: "Take a deep breath."

Record the reading in mm on the stadiometer just before the participant exhales.

Script: "Breathe out."

5) The participant should step away from the stadiometer, and the procedure should be repeated for the second measurement.

If the two measurements differ by ≥ 4 mm, two additional measurements should be taken.

6) Deviations/exceptions to standard positioning:

For participants with extremely kyphotic posture, it may not be possible to obtain contact between the headboard and scalp when the participant's buttocks are against the wall-plate. In this case, measure sitting height with the participant sitting sideways (side of arm against the wall-plate) and positioned so the headboard contacts the scalp. Record that the participant was measured in the sideways position on the scoring form so that follow-up measurements will be made in the same position.

6. Procedures for Height Measurement at Home

To be developed.

7. Alert Values/Follow-up/Reporting

Height will be included in the form given to the participant at the time of the visit. These measurements will also be included in the final reports to the participant and their physician.

8. Quality Assurance

8.1 Training Requirements

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

- Read and study manual
- Attend Health ABC training session on techniques (or observe administration by experienced examiner)
- Practice on other staff or volunteers with a special emphasis on heavy participants and women 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

8.2 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

8.3 Quality Assurance Checklist

- 0.5 kg weight on stadiometer
- Hairpiece removed, hair style altered, if necessary

Standing Height

- Checks that heels are together
- Checks for heels, buttock, scapula touching wall-plate (all touching if possible)

Sitting Height

- Knees straight ahead, hands resting on thighs

- Checks for the back of knees close to, but not touching, edge of seat
- Checks for buttocks and scapula touching wall-plate
- Uses designated seat or measures/checks height of sitting surface
- Appropriate adjustments in obese and kyphotic participants
- Checks for Frankfort Horizontal Plane
- Sideways technique for kyphotic posture, if necessary
- Brings headboard down firmly on head
- Checks for contact with scalp, moves hair if necessary
- Measurement taken after inhaling, before exhaling
- Correct script
- Two measurements made
- Participant steps away from stadiometer between measurements
- Two more measurements made if first two differ by ϵ 4 mm
- Reviews form for completeness
- Correctly completes form
- Calibration log up to date
- Conversion chart for giving ppt height in inches

9. References

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3. Ortiz O, Russel M, Daley Tl, et al. Differences in skeletal muscle and bone mineral mass between black and white females and their relevance to estimates of body composition. *Am J Clin Nutr* 1992;55:1-6.
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5. Gallagher D, Visser M, Sepulveda D, et al. How useful is body mass index for comparison of body fatness across age, gender, and ethnic groups? *Am J Epidemiol* 1996;143:228-239.

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10. Form