Last updated: 27 March 2008

7. Measurement protocols

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7.1 Introduction

In this chapter recommended measurement protocols are described. The recommendations are based mostly on the review of the experience from earlier HES and recent developments in the survey methods, which the FEHES Project has prepared and published separately [Ref: FEHES Review]. For the risk factors of major chronic diseases, the recommended measurement protocols are similar to those of the European Health Risk Monitoring project (EHRM), with updates due to recent developments in the measurement technology [REF: EHRM Recommendation]. The protocol for automated blood pressure measurement is taken from the World Health Organisation's STEPwise approach to Surveillance (STEPS) recommendation [Ref: STEPS].

For each recommended measurement, we will describe the relevance of the measure, the standardized equipment and way to perform and record the measure, exclusion criteria and quality control measures.

This chapter includes currently standard measurement protocols for the core examination measurements, which are expected from all HES, and for a number of optional measurements, primarily on measurements of functional capacity in the elderly. Questionnaire items relevant for these measurements are also included here. Other questionnaire items that can be collected as part of the HES are described in Chapter 6.

This chapter is structured in such a way that protocols for other measurements can be added later.

7.2 Height

Age
Height can be measured in participants (who can stand) aged 4 years and older.

Exclusion criteria
Height is not measured for people in a wheelchair, persons who have difficulty to stand straight, and participants with a hairstyle (e.g. Afro or Mowhawk) that prevents proper use of the height equipment. For the latter group, self reported height is acceptable if recorded on the collection form.

Time of measurement
The measurement of height will take about 3 minutes.

7.2.1 Equipment

Equipment for height

- The most reliable device to measure height is the portable stadiometer (and a fixed stadiometer). This device can be used in different settings, including mobile units, and can be adjusted to surfaces that are not completely flat.
- Carpenter's level.
- Calibrated length rods of 150 cm and 200 cm.

7.2.2 Measurement protocol

Setting up the measurement site

For measuring height with the stadiometer, the height rule is taped vertically to the hard flat wall surface with the base at floor level. A carpenter's level is used to check the vertical placement of the rule.

The floor surface next to the height rule must be hard. If no such floor is available a hard wooden platform should be placed under the base of the height rule.

Calibration of height rule

At the beginning and end of each examination day, the height rule should be checked with standardized rods and corrected if the error is greater than 2 mm. The results of the checking and recalibrations are recorded in the log book.

Protocol for measuring height

1. Participants are asked to remove their shoes, heavy outer garments, and hair ornaments and head dress.
2. The participant is asked to stand with his/her back to the height rule. The back of the head, back, buttocks, calves and heels should be touching the stadiometer, feet together. The top of the external auditory meatus (ear canal) should be level with the inferior margin of the bony orbit (cheek bone). The participant is asked to look straight.
3. The head piece of the stadiometer or the sliding part of the measuring rod is lowered so that the hair (if present) is pressed flat.
4. Height is recorded to the resolution of the height rule (i.e. nearest millimeter/half a centimeter). If the participant is taller than the measurer, the measurer should stand on a platform so that he/she can properly read the height rule.
5. If the person is taller then the maximum height of the stadiometer, the self reported height is acceptable and recorded on the collection form.
6. If a participant is excluded from height measurement, the reason should be recorded in the data collection form (see textbox 6.1).

Textbox 6.1

Example of the height measurement recording form.

Height measurement:

Participant's identification code |__||__||__||__||__||__|

Person measuring height (identification code) |__||__|

Date (ddmmyyyy) |__||__|.|__||__|.|__||__||__||__|

Height (cm) |__||__||__|.|__|

If no height measurement was made, give reason: |__|

1=hairstyleheadgear
2 = wheelchair bound
3 = unsteady stance
4 = height exceeds upper limit of stadiometer (upper limit of the stadiometer: |__||__||__| cm)
5 = refused
6 = other, specify:

If no height was measured, self reported height is: |__||__||__|.|__|

Describe special conditions, if any: ……
……..

7.2.3 HIS questions for height

No questions are recommended.

7.2.4 Quality control

To be completed.

7.3 Weight

Age
Weight can be measured in participants aged 4 years and older.

Exclusion criteria
Weight is not measured for wheelchair bound individuals or persons who have difficulty standing steady. For the latter group, self reported weight is acceptable if recorded on the collection form.

Time of measurement
The measurement of weight will take about 3 minutes.

7.3.1 Equipment

Equipment for weight

- Balanced beam scale or an electronic scale which has been issued an EC type-examination certificate for medical use. Such a scale can be calibrated.
- Several calibrated weights (e.g. 10 kg or 20 kg each) that can be combined to give test weights between 50 kg and 100 kg.

7.3.2 Measurement protocol

Setting up the measurement site
The scale should be placed on a hard-floor surface (not on a floor which is carpeted or otherwise covered with soft material). If there is no such floor available, a hard wooden platform should be placed under the scale. A carpenter's level should be used to verify that the surface on which the scale is placed is horizontal.

Calibration of scale
Calibration should occur at the beginning and end of each examining day.
The scale is checked using the standardized weights and calibration is corrected if the error is greater than 0.2 kg. The results of the checking and the recalibrations are recorded in a log book. The balanced beam scale is balanced with both sliding weights at zero and the balance bar aligned. For calibrating an electronic scale, follow the instructions of the specific scale. Note that the reading of an electronic scale depends on the gravity of each location. Therefore its calibration is particularly important whenever a new examination site is set up.

Protocol for measuring weight

1. Participants are asked to remove their heavy outer garments (jacket, coat, trousers, skirts, etc.) and shoes. If subjects refuse to remove trousers or skirt, at least make them empty their pockets and record the fact in the data collection form (see textbox 6.2).
2. The participant stands in the centre of the platform, weight distributed evenly to both feet. Standing off-centre may affect measurement.
3. The weights are moved until the beam balances (the arrows are aligned). (This concerns the balanced beam scale only).
4. If the persons weight exceed the maximum of the scale, the self recorded weight is acceptable and recorded on the collection form.
5. If the participant tells that she is pregnant, the weight before the pregnancy should be asked and noted on the collection form under self reported weight.
6. The weight is recorded to the resolution of the scale (the nearest 0.1 kg or 0.2 kg).

Textbox 6.2

Example of the Weight measurement recording form.

Weight measurement:

Participant's identification code |__||__||__||__||__||__|

Person measuring weight (identification code)	|__||__|
Date (ddmmyyyy)	|__||__|.|__||__|.|__||__||__||__|
Weight (kg)	|__||__||__|.|__|
If participant is not weighed, give reason: 1 = pregnant women 2 = wheelchair bound 3 = unsteady stance 4 = weight exceeds upper limit of scale (upper limit of the scale: |__||__||__| kg) 5 = refused 6 = other, specify:	|__|
If no weight was measured,self reported weight is (kg)	|__||__||__|.|__|
Describe special conditions, if any: …….. ……	

7.3.3 HIS questions for weight

No questions are recommended.

7.3.4 Quality control

To be completed.

7.4 Waist and hip circumferences

Age
Measuring the waist and hip circumference is for adult participants in the age of 18 years and older.

Exclusion criteria
Waist and hip circumferences are not measured for persons in a wheelchair or persons who have difficulty standing straight.
If the participant is immobile or refuses to have his/her waist- or hip circumference measured, this fact should be recorded in the data collection form (see textbox 6.3). Self-reported waist- or hip circumference is not acceptable as a substitute. If the waist- or hip circumference exceeds the length of the tape, this fact should be recorded in the data collection form together with the maximum length of the tape.

Time of measurement
The measurement will take about 5 minutes.

7.4.1 Equipment

Equipment for measuring waist and hip circumference
- Constant tension tape, not stretchable (for example, Figure Finder Tape Measure)
- Full body length mirror with 10cm×10cm grid lines
- Carpenter's level

7.4.2 Measurement protocol

Setting up the measurement site
A private area is necessary for this measurement. This could be a separate room, or an area that has been screened off from other people.
The full body length mirror is placed against the wall or if the mirror stands on its own feet next to the measurement place. Using the carpenter's level, it should be verified that the gridlines on the mirror are horizontal.

Checking the tape
The length of the measuring tape is checked with the calibrated length rod (usually the 150 cm one) at least once per month. If the measuring tape is stretched it should be replaced

Protocol for measuring waist and hip circumferences
This measurement should be taken without clothing, that is, directly over the skin.
If this is not possible, the measurement may be taken over light clothing and record this fact in the data collection form. It must not be taken over thick or bulky clothing. This type of clothing must be removed.
If the participant tells that she is pregnant, the measurement will not be executed.

7.4.2.1 Waist circumference

Position of waist circumference measurement
Waist circumference should be measured at a level midway between the lower rib margin and iliac crest with the tape all around the body in horizontal position.

Waist circumference measurement procedure
1. Participants are asked to remove their clothes, except for light underwear. If this is not possible, for example due to cultural reasons, the alternative is to measure the circumference on the subject without heavy outer garments and record this fact in the data collection form. Tight clothing, including the belt, should be loosened and the pockets emptied.

2. The measurer should stand at the side of the participant in order to have a clear view of the mirror.

3. Participants should be standing with their feet fairly close together (about 12-15 cm) with their weight equally distributed to each leg. Participants are asked to breathe normally; the reading of the measurement should be taken at the end of gentle exhaling. This will prevent subjects from contracting their abdominal muscles or from holding their breath.

4. The measuring tape is held firmly, ensuring its horizontal position. Use the grid lines on the mirror to verify that the tape position is horizontal all around the waist. The tape should be loose enough to allow the observer to place one finger between the tape and the subject's body.

Waist circumference exceeds the length of the tape
If the waist circumference exceeds the length of the tape, this fact should be recorded in the data collection form together with the maximum length of the tape.

7.4.2.2 Hip circumference

Measurement of the hip circumference is the same as for waist circumference, except for tape position. Hip circumference should be measured as the maximal circumference over the buttocks. The gridlines on the mirror are used to verify that the tape position is horizontal all around the body.

Hip circumference exceeds the length of the tape
If the hip circumference exceeds the length of the tape, this fact together with the maximum length of the tape, should be recorded in the data collection form (textbox 6.3).

Textbox 6.3

Example of the waist hip measurement recording form.

Waist and hip circumference measurement:

Participant's identification code	|__|__|__|__|__|__|__|
Person measuring waist and hip (identification code)	|__|__|
Date (ddmmyyyy)	|__|__|.|__|__|.|__|__|__|__|
Waist circumference (cm)	|__|__|__|.|__|
Hip circumference (cm)	|__|__|__|.|__|
If no waist/hip circumference measurement was made, give reason: 1 = pregnant woman 2 = wheelchair bound 3 = unsteady stance 4 = circumference exceeds length of tape (length of tape: |__|__|__| cm) 5 = refused 6 = other, specify:	|__|
Measurement was done over: 1 = light underwear 2 = normal clothes (without heavy garments) 3 = other specify:……	|__|
Describe special conditions, if any:	

7.4.3 HIS questions

No questions are recommended.

7.4.4 Quality control

To be completed.

7.5 Blood pressure

Tradionally, blood pressure has been measured using the mercury sphygmomanometer. The EHRM recommendations from 2002 are based on the use of mercury sphygmomanometer. Due to toxicity of the mercury, the mercury sphygmomanometers may in future become banned and therefore we have to look for alternative blood pressure measuring devices. In some of the previous health examination surveys, automated blood pressure measurement devices have been used. In the market, there is also number of aneroid sphygmomanometers but we don't know any national HES in which they would have been used.

We will describe here the measurement protocol for both the mercury sphygmomanometer and the automated blood pressure measuring device. What is common for both devices is the preparation for the measurement. The actual measurement protocol differs between devices. Preparation for the measurement and the measurement protocol by mercury sphygmomanometer follow the EHRM protocol, while the measurement protocol by automated blood pressure measurement device follows the WHO STEPS protocol.

Age
The blood pressure measurement can be conducted by adult participants 18 years and older.

Exclusion criteria
None

Time of measurement
It will take 15 minutes to measure the blood pressure.

7.5.1 Preparation for the measurement

7.5.1.1 Basic conditions

Before the blood pressure measurement begins the following conditions should be met:

1. Subject should abstain from eating, drinking (anything else than water), smoking and taking drugs that affect the blood pressure one hour before measurement.
2. Because a full bladder affects the blood pressure it should be emptied.
3. Painful procedures and exercise should not occurred within one hour.
4. Subject should be sitting quietly for about 5 minutes.
5. Subject should remove outer garments and all other tight clothes. The sleeve of shirts, blouses, etc. should be rolled up so that the upper right arm is bare. The remaining garments should not be constrictive and the blood pressure cuff should not be placed over the garment.
6. Blood pressure should be measured in a quiet room with comfortable temperature. The room temperature should be recorded.
7. The time of day should be recorded.
8. The blood pressure measurer should be identified on the blood pressure data recording form.
9. Blood pressure measurement device(s) should be numbered and the number of the device should have been recorded.

7.5.1.2 Position of the subject

Measurement should be taken in sitting position so that the arm and back are supported. Subject's feet should be resting firmly on the floor, not dangling. If the subject's feet do not reach the floor, a platform should be used to support them. If subject cannot sit and the measurement is taken on supine posture this should be recorded.

7.5.1.3 Position of the arm

The measurements should be made on the right arm whenever possible. If right arm cannot be used for the measurement (arm is amputated or has rashes, adhesive dressing, casts, open sores, hematomas, wounds, arterovenous shunt or any other intravenous access device), the use of the left arm should be recorded.

The subject's arm should be resting on the desk so that the antecubital fossa (a triangular cavity of the elbow joint that contains a tendon of the biceps, the medial nerve, and the brachial artery) is at the level of the heart and palm is facing up. To archive this position, either the chair should be adjusted or the arm on the desk should be raised, e.g. by using a pillow. The subject must always feel comfortable.

7.5.1.4 Selection of the cuff

The greatest circumference of the upper arm is measured, with the arm relaxed and in the normal blood pressure measurement position (antecubital fossa at the level of the heart) using a non-elastic tape. The measurement should be read to the nearest centimetre. This reading should be recorded.

Select the correct cuff for the arm circumference and record the size of the selected cuff. The width of the bladder of the cuff should be at least 40% of the arm circumference and the length of the bladder at least 80% of the arm circumference. In the EHRM protocol, instructions are given how to determine the correct arm circumference for the different cuff sized. For example:

Arm circumference	**Width of the bladder of the cuff**
≤ 25 cm	8 cm
25 cm < arm circumference < 35 cm	12 cm
≥ 35 cm	16 cm

The cuff should be places on the right arm so that its bottom edge is 2-3 cm above the antecubital fossa. The top edge of the cuff should not be restricted by clothing.

A set of 3-4 cuffs with different size should be available and special attention should be paid to the use of proper cuff width in relation to the size of the arm. The length of the bladder should be enough to encircle at least 75-80% of the arm and the arm circumference should be measured in the middle between the axilla and the antecubital space of the upper arm, with the arm relaxed and in the normal blood pressure measurement position (antecubital fossa at the level of the heart), using a non-elastic tape. The measurement should be read to the nearest centimetre. This reading should be recorded in the data.

7.5.1.5 Number of measurements

Three measurements should be taken one minute apart.

7.5.2 Mercury sphygmomanometer

The measurer should outline the procedure briefly to the subject. In particular, he or she should warn the subject of the minor discomfort caused by inflation and deflation of the cuff and tell the subject that the measurement will be repeated three times.

7.5.2.1 Equipment

For survey blood pressure measurements the following equipment is required:

- simple mercury sphygmomanometer;
- stethoscope;
- 3-4 cuffs;
- non-elastic measuring tape;
- stopwatch.

7.5.2.2 Measurement protocol

The bell of the stethoscope should be used because it gives clearer sounds than the diaphragm.

1. The radial pulse is palpated and the pulse rate is counted for 30 seconds, measured by a digital wrist watch or one with second hand.
2. Record 30-second pulse count and whether pulse was regular.
3. The manometer should be placed so that the scale is at eye level, and the column perfectly vertical. The subject should not be able to see the column of the manometer.
4. Determining the peak inflation level:
    i. The mercury column has to be at 0 level.
    ii. The subject's radial pulse is again palpated.
    iii. iii. The cuff is inflated and the level of the top of the meniscus of the mercury column is noted at the point when the radial pulse disappears. The cuff is immediately deflated by completely opening the valve.
    iv. The peak inflation level is determined by adding 30 mm to the pressure where the radial pulse disappeared.
5. Venous blood pool in the forearm is normalized by waiting at least 30 seconds or by raising the arm for 5-6 seconds.
6. The brachial pulse is located and the bell of the stethoscope is placed immediately below the cuff at the point of maximal pulsation. If it is not possible to feel the brachial pulse, the bell of the stethoscope should be placed over the area of the upper arm immediately inside the biceps muscle tendon. The bell should not touch the cuff, rubber or clothing.
7. The cuff is rapidly inflated to the peak inflation level and then deflated at a rate of 2 mmHg per second.
8. The pressure should be reduced steadily at this rate until the occurrence of the systolic level at the first appearance of a clear, repetitive tapping sound (Korotkoff Phase 1) and diastolic level at disappearance of repetitive sounds (Phase 5) have been observed. Then the cuff should be rapidly deflated by fully opening the valve of the inflation

bulb. Note: There may be a brief period (auscultatory gap) between systolic and diastolic pressure, when no Korotkoff sounds are heard. Therefore, the 2mmHg/second deflation should be continued until the diastolic blood pressure is definitely established. If Korotkoff sounds persist until the cuff is completely deflated, a diastolic blood pressure of 0 should be recorded.

9. The measurements should be recorded to the nearest 2 mmHg. If the top of the meniscus falls half way between two markings, the marking immediately above is chosen. The subject is not told the blood pressure values at this point.
10. After one minute of wait to allow redistribution of blood in the forearm a second measurement is made by repeating steps 7 to 9. The subject should not change position during the wait.
11. After another one minute a third measurement is made by repeating steps7 to 9.
12. The subject may now be told the measurement values.

7.5.3 Automatic blood pressure measurement

7.5.3.1 Equipment

For survey blood pressure measurements the following equipment is required:

- Automated blood pressure measurement device
- 3-4 cuffs
- Non-elastic measuring tape

7.5.2.2 Measurement protocol

1. Insert the air tube of the cuff to the air jack of the machine. The cuff must be airless.
2. Open the battery compartment and insert batteries or use the adapter.
3. Press the ‘On’ button, all the symbols on the display light up for approximately two seconds in order to check the display.
4. Then all the symbols disappear and the air release symbol begins to flash
5. Wrap the cuff around the arm so that the coloured band (indicating the centre of the bladder) is positioned 2 – 3 cm above the elbow joint on the inside of the arm.
6. Close the cuff with the fabric fastener. The green area of the cuff must cover the brachial artery.
7. Push the start button, the device determines automatically the correct level of inflation pressure.
8. When the target inflation values are reached, the air is automatically released. The value in the display counts downwards.
9. As soon as the monitor detects the pulse, the symbol begins to flash.
10. When the monitor no longer detects the pulse whilst the cuff pressure is dropping, the systolic and diastolic pressure are displayed
11. After one minute of wait the second measurement is made by repeating steps 7 – 10. The subject should not change position during the wait.
12. After another one minute the third measurement is made by repeating step 7 – 10.
13. The subject may now be told the values of the measurement.

7.5.4 HIS questions

Questions below are from the European Health Care Module:

Introduction 14
Now I would like to ask you some questions about your blood pressure.
PA.4 Has your blood pressure ever been measured by a health professional?
• Yes _ 1
• No _ 2 → GO TO INTRODUCTION 15
• don't know _ 8 → GO TO INTRODUCTION 15
• refusal _ 9 → GO TO INTRODUCTION 15
PA.5 When was the last time that your blood pressure was measured by a health professional?
• Within the past 12 months _ 1
• 1-5 years ago _ 2
• More than 5 years ago _ 3
• don't know _ 8
• refusal _ 9

As an alternative, the questions below (from EHRM) are based on MONICA.

HBP1 When was your blood pressure last measured by a health professional? |__|
1 = Within the past 12 months
2 = 1-5 years ago
3 = Not within the past 5 years

HBP2 Have you been told by a health professional in the past year (12 months) that you have elevated blood pressure or hypertension? |__|
1 = Yes
2 = No
3 = Uncertain

HBP3 Are you currently taking medication prescribed by a doctor to lower your blood pressure? |__|
1 = Yes
2 = No
3 = Uncertain

HBP4 Has a doctor in the past year ordered you to change your way of life, in order to lower your blood pressure?
1 = Yes
2 = No
3 = Uncertain

7.5.5 Selection and training of the measurers

When recruiting the measurers one should remember:

- Trained nurses and paramedics often are better blood pressure measurers than doctors.
- The work load of measurers should not cause fatigue, which leads to false measurements.

All candidates have to undergo thorough training covering theory and practice of indirect blood pressure measurements. Theory training is same regardless of the used measurement device but for the practical training, there are some device specific features.

During the theoretical lectures the blood pressure measurement protocol is reviewed and discussed in detail. Possible problems during field operation are examined and solutions analyzed. Also, the quality control measures during the survey are presented, e.g. monitoring for terminal digit preference.

The practical training includes test measurements which real subjects.

Special features for mercury sphygmomanometer

After persons have been recruited as candidates for the blood pressure measurement by auscultation method, they have to pass a hearing test administered by an audiometrist, to ensure they have no loss of hearing in either ear.

The practical training includes

- Training with tape of recorded Korotkoff sounds.
- Training with actual subjects (Y-tube, repeated measurements).

Before being accepted as blood pressure measurers, the candidates have to pass a certification test that could be based on similar techniques as the training methods, but now a predefined minimal percentage of correct measurements have to be achieved for successful certification.

Special features for automated device

No special requirement for the training.

7.5.6 Quality control

7.5.6.1 During the survey

Quality assurance procedures are mainly not dependent on the used device. There are some device specific features which are given separately for mercury sphygmomanometer and automated blood pressure measurement device.

It is important to continuously monitor the performance of blood pressure measurers to avoid an accumulation of data that will have to be discarded because of unreliability. Monitoring every blood pressure measurement onsite is not possible but there are several simple indicators that can be calculated regularly for monitoring purpose. For monitoring to be effective it is desirable that measurements from the field are reviewed regularly, preferably daily.

For each measurer the following information should be checked regularly during the survey:

1. Availability of data for selected cuff width, measured arm circumference, room temperature and time of the day of the blood pressure measurement. This will detect if some measurer is omitting some parts of the protocol.

2. The proportions of identical readings for the first and second measurements, the second and third measurements, and for all three measurements of systolic and diastolic measurements separately. This will detect if a measurer is actually taking three measurements (identity should be rare).
3. Monitor that daily/hourly work load does not exceed agreed limits.
4. Cross-tabulation between used cuff width and measured arm circumference. This will detected compliance with the protocol.
5. Difference between systolic and diastolic blood pressure should be monitored.

If some problems are detected they need to be immediately discussed with the individual measurer and corrective action taken. Just letting the measurer know that he/she has problems with the measurement procedures may suffice. Otherwise, the measurer should be retrained and re-certificated or dismissed.

During extended surveys, a refresher session for all blood measurers every three months is a desirable practice.

The room temperature should be monitored during the survey on a regular basis and adjusted when needed.

External auditor should make surprise visit to the examination sites and observe measurers' performance by documenting step-by-step compliance with the protocol. Auditors should also act as guest subject and participate actively in all steps of blood pressure measurement.

Special features for mercury sphygmomanometer

Measurers should check every day before the first blood pressure measurement are made that the mercury column of the sphygmomanometer is at zero, that the mercury column falls smoothly when the cuff is deflated, and that the column latches properly into vertical position. Any equipment failing these tests has to be replaced. The results of checking should be recorded in a log book.

For each measurer distribution of terminal digits for systolic and diastolic measurements (separately) should be checked regularly. This will detect if

i. some measurers tend to prefer some digits over others (for example zero preference), indicating unreliable detection of Korotkoff sounds;
ii. some measurers use odd digits that, by protocol, should not be used.

For each measurer, means and standard deviations of the systolic and diastolic blood pressure measurements should be checked regularly. This will detect if some measurer produces systematically lower or higher readings than the average of the team.

Special features for automated device

Calibration of the equipment before the survey by an official institute and also during the survey at least once a year.

The batteries of the device should be checked every morning before the first blood pressure measurement is made as well as few times during the day.

For each device, the mean and standard deviations of the systolic and diastolic blood pressure measurements should be checked regularly. This will detect if some device produces systematically lower or higher readings than the average.

7.5.6.2 Quality assessment after the survey

After the survey, it is important to assess and document the overall quality of blood pressure measurements. This information can be used to verify that results presented in publications are accurate and comparable with other studies. In addition, the information will also be useful for planning the future surveys and for designing the training of the future blood pressure measurers.

The retrospective quality assessment report for blood pressure measurements no longer focus on the data of individual measurers, but instead concentrates on the pool of all measurements. The report should include the following information:

1. Item response rates for blood pressure measurement.
2. Availability of data on:
    a. used cuff width
    b. measured arm circumference
    c. room temperature
    d. time of the day of the blood pressure measurement
3. Proportion of incomplete measurements
4. Proportion of identical measurements for systolic and diastolic measurements separately
5. Difference between two sequential measurements for systolic and diastolic measurements separately
6. Cross-tabulation between cuff widths and arm circumferences
7. Mean and standard deviation of the room temperature.

And additional if the mercury sphygmomanometers are used:

1. Proportion of odd-valued readings for systolic and diastolic measurements separately.
2. Distributions of terminal digits for systolic and diastolic measurements separately.

Textbox 6.4

Cuff selection rules*:

Cuff width	**12X22 cm**	**16 X 30 cm**	**16 X 36 cm**	**16 X 42 cm**
Arm circumference	22 cm -26 cm	27 cm - 34 cm	35 cm – 44 cm	45 cm – 52 cm

* It is suggested that the cuff selection rules are printed on the top of the form. The rules shown here are an example, and the numbers should be substituted by those of the cuff sizes actually used in the survey.

Data recording form blood pressure measurement:

Participant's identification code	|__|__|__|__|__|__|__|__|
Questions to the participant	
Person measuring blood pressure (identification code)	|__|__|
Type of measuring device 1 = Mercury 2 = automatic 3 = other specify:…..	|__|
Number of blood pressure device	|__|
Date (ddmmyyyy)	|__|__|.|__|__|.|__|__|__|__|
Time of day (hh:mm)	__|__|.|__|__|
Room temperature (^{o}C)	|__|__|
Arm used for blood pressure measurement 1 = right 2 = left	|__|
Reason for measruing on the left arm	…….
Position of subject 1 = sitting 2 = supine	|__|
Maximum arm circumference (cm)	|__|__|
Cuff size used 1 = 12X22 cm 2 = 16x30cm 3 = 16 x36cm 4 = 16x42 cm	|__|
pulse count	|__|__|__|
Peak inflation pressure (mmHg)	|__|__|__|
Blood pressure measurement	**1st measurement** : Systolic: |__|__|__| Diastolic |__|__|__| **2nd measurement** Systolic: |__|__|__| Diastolic |__|__|__| **3rd measurement** Systolic: |__|__|__| Diastolic |__|__|__|

7.6 Blood collection

Venous blood samples are usually collected for the measurement of blood lipids and glucose. For lipid measurements, serum should be used. For glucose measurements, plasma is used. It is often advisable to collect additional serum and plasma samples for possible future analysis of fatty acids and lipoproteins, biomarkers and antibodies, and whole blood for DNA. The collection of samples blood samples for the analysis of blood lipids and glucose are described here.

Minimal set of blood measurements
The minimal set of analyses contains the lipid analyses:
- Total Cholesterol
- HDL-cholesterol

Extension of the set of blood samples can be done by taking (citrate + sodium fluoride) samples for measuring:
- Glucose

Age
Blood drawing is possible from participants in the age of 4 years and older.

Exclusion criteria
Reason for exclusion of participants:
- Participant is on anticoagulation therapy
- Participants with bleeding disorder (e.g. haemophilia, low platelets, etc).

Time for the measurement
Drawing blood samples will take about 15 minutes.

7.6.1 Equipment

Equipment for sample drawing
- needles (preferably vacutainer needles), size 20G to 22G
- vacutainer tubes
- vacutainer holder
- tourniquet
- micropore tape
- adhesive dressing
- rubber gloves
- pillow or other support
- separate stoppers for opened vacuum tubes and non-vacuum tubes
- needle disposal box

Chemically clean evacuated tubes with appropriately reduced pressure should be used in sample drawing. If plasma specimens are taken, EDTA should be used as anticoagulant. Tubes with liquid EDTA reduce the risk of haemolysis that sometimes occurs with tubes using EDTA in powder form. For glucose determination, tubes with citrate and sodium fluoride are needed.
Plastic vacuum tubes are preferred to glass tubes. Plastic vacuum gel tubes are most convenient if available.
Plain tubes can be used for determination of lipids (total cholesterol and HDL cholesterol).

If vacuum tubes are not used or tubes are opened for freely flowing samples, stoppers which do not react with blood constituents should be available.

Equipment for handling, transfer and storage
For handling, transfer and storage of blood samples the following equipment is needed:

- transfer and storage tubes (note that some of these should be freezable)
- disposable pipettes or pipettes with changeable apex
- centrifuge, capable of 3000g. If gel tubes are used, centrifuge should have swinging bucket rotor
- timer
- racks for tubes
- special boxes for tube transfer and storage
- set of labels with identification codes or other method to mark the tubes (note that these should not be vulnerable to freezing)
- refrigerator
- freezer (as required)

7.6.2 Protocol for drawing blood samples

Fasting before the sample collection
The serum samples for total cholesterol and high density lipoprotein cholesterol can be taken at any time of the day with the subject non-fasting. In the case of drawing non-fasting samples, blood sample drawing should be spread throughout the day.

If fasting glucose, lipoprotein fractions and fasting triglycerides are to be measured the samples should be collected after a fasting period. The fasting period should be minimally 8 hours (overnight) and maximally 14 hours (too long fasting causes major changes in energy metabolism with implications for blood triglycerides)[i]. In practise this means overnight fasting, and that fasting samples can only be taken in the morning, and fasting samples can be expected only from those who are invited to come to the examination in the morning.

Position of subject
All blood samples should be drawn in a sitting position. Preferably, blood should not be collected from the arm that is used for blood pressure measurement, i.e. blood should usually be drawn from the left arm.

Use of tourniquet
Prolonged venous occlusion can cause changes in concentrations of blood constituents. Therefore, the use of a tourniquet should be minimized. If a tourniquet is used to search for a vein, it should be released before withdrawal of blood begins. In any case, the use of a tourniquet should be limited to less than one minute.

Sample drawing procedure
Blood samples should be taken from the vein in the antecubital fossa. Before blood collection, the subject should remove tight clothes that might constrict the upper arm. During blood collection, the arm should rest on a pillow or other supportive prop.

The fieldworker sets the tourniquet around the upper arm of the subject, searches the proper vein by inspecting and palpating. The vein can be anchored by placing the thumb about two centimetres below the vein and pulling gently to make the skin a little taut. After that, the

needle, bevelled upward, should be pushed smoothly and quickly into the vein, to minimize the possibility of haemolysis as a result of vascular damage. Immediately after the insertion, the tourniquet should be released to minimize the effect of hemoconcentration.

The order in which the various tubes are filled is determined by the risk of contamination and coagulation. NCCLS recommended the order: 1. tubes for serum, 2. citrate filled tubes, 3. gel tubes, 4. heparin filled tubes, 5. EDTA filled tubes, 6. fluoride filled tubes. Another consideration that might affect the order of tube filling is the priority of the assay for which the tubes are needed, in case insufficient blood flow cuts the sampling short. Then the order will be: 1. tubes for serum, 2. tubes filled with fluoride.

If there are any problems with blood flow during blood taking (e.g. collapsing vein), the procedure should be discontinued and an attempt should be made on the other arm. If that also fails, no further attempts should be made and the blood collection for this particular participant should be recorded as "failed".

If vacuum tubes are used, the tube is placed into the adapter. When taking several tubes the next tube should be changed immediately after the previous one is filled. In case there is suspicion that not enough blood will be obtained to fill all the tubes, they should be filled in the order of priority of the assay for which they are needed. To assure proper mixing tubes pre-filled with EDTA, gel or fluoride should be inverted smoothly about 8 times towards the stopper while the next tube is filling up (It may simplify the manual of operations to prescribe inverting all tubes, since it does not harm plain tubes).

Before the subject leaves the examination site and before the rack is moved anywhere, all the tubes should be labelled with the subject identification code.

Clotting
After the identification of the tubes the timer should be started. The blood samples are allowed to clot at 15-24 °C. If vacuum gel tubes are used, the temperature should be at least 20°C (optimum 20-22°C), because the gel viscosity changes in colder temperature. The clotting time should be minimally 30 minutes and maximal one hour.

Centrifuging
If samples (plasma) for glucose measurements are taken, the samples should be centrifuged no later than 20-35 minutes after the sample is drawn.

For serum samples, blood should be centrifuged within one hour after blood collection. Alternatively, they should be cooled in the refrigerator immediately after clotting and centrifuged at the end of the day.

The centrifuge should not be cold and blood specimens should be centrifuged at a temperature 15-24°C. For serum preparation blood should spin for 10 minutes at 1500 g. For plasma, the conditions are 15 minutes at 2000g to 3000g. For all the participants a form should be filled in with information about the handling of the blood samples (see appendix 2).

Separation of serum or plasma
After centrifugation, the tubes should be inspected carefully in order to recognize possible hemolysis. If vacuum gel tubes are used, it should be checked that the gel surface is straight, the layers are properly separated, there are no red cells above the gel surface, there are no

fibrin filaments in the sample and the sample is not coagulated after the centrifugation. If the serum samples are pooled the haemolysed samples should be kept separate.

The serum/plasma should be promptly separated from clot or cells and transferred to a clean tube. The white cell layer should not be transferred with the plasma. If the vacuum gel tube is used the separated serum can be poured to a clean tube otherwise the pipette should be used. After all serum/plasma is separated to proper transfer/storage tubes the tubes should be carefully marked with sticker or other method with identification code.

Storage and transfer of serum/plasma samples

It is recommended that the assays for total cholesterol, HDL-cholesterol and triglyceride levels should be done on the day of sample collection. For possible transfer from the examination site to the laboratory the samples should be properly packed and cooled, but not frozen.

(If HDL-cholesterol is analyzed with the precipitation method, analysis should be done on the day of blood collection. However, nowadays it is recommended that HDL cholesterol is analyzed using a direct methods.)

If analysis is not possible on the day of sample collection, but within the next three days, it is recommended that analyses should be carried out from non-frozen samples and samples should meanwhile be stored at +4°C.

If analysis is not possible within three days, the serum or plasma should be immediately frozen at preferably -70°C, but at least -20°C. While transporting frozen samples, care has to be taken to avoid thawing.

For transport, samples should be properly marked with identification codes and transfer lists should be kept in order to check for possible disappearance of samples.

Samples frozen at -20°C should be analyzed within six months. If later analyses will be done, the samples must be frozen at -70°C.

7.6.3 Safety

Medical doctor for back-up
During the examinations, the nurse / medical assistant who is taken the blood samples, should know who they can contact (medical doctor) in case something happens with the participant during or after the blood drawing.

Gloves
For safety reasons, gloves should be used during blood drawing and handling. The use of gloves may depend on local instructions/protocols. If personnel drawing blood samples are not using gloves, they should wash their hands between all the participants.

Vaccination for Hepatitis B for medical personnel
All the medical personnel working with needles should be vaccinated for Hepatitis B. The head of the department / project leader is responsible for the immunisation of the staff.

Needle stick injuries
At the place of the examination there should be a protocol for needle stick injuries. Any personnel who sustain a needle stick injury should seek immediate advice from the responsible local health staff.

What to do after an incident?
- After the needle injury, let the wound bleed very well and clean it with water or physiological saline.
- Disinfect the wound with disinfectants
- Contact the local health professional who is responsible for infectious diseases.

Disposal of needles and other materials
Needle disposal boxes should be available for all personnel drawing blood samples. Needles should be released from adapters directly to needle disposal box. Needles should never be re-sheathed after use. The disposal boxed should not be allowed to become overfull (maximum filled 75%). All the rest materials (needles / rest blood) should be processed in an appropriate way, and following any local rules

7.6.4 Qualification and training of personnel

The person performing the blood collection should be a certified phlebotomist. In most countries, this certification is offered through national accrediting agencies for clinical laboratory sciences. Employing a certified phlebotomist for the invasive blood collection procedure provides a measure of safety for the participant, but it also provides some medical-legal protection for the survey organizers, in case something should go wrong.

In preparation for the survey, blood collection personnel should be made familiar with the aims of the survey and the protocol details that pertain to blood collection. The safety measures for protection of participant and technician should be reviewed.

7.6.5 HIS questions

The following questions complement the HES, by assessing awareness and treatment of hypercholesterolemia and diabetes:

Introduction 15
Now I would like to ask you some questions about your blood cholesterol.

PA.6 Has your blood cholesterol ever been measured?
• Yes _ 1
• No _ 2 → GO TO INTRODUCTION 16
• don't know _ 8 → GO TO INTRODUCTION 16
• refusal _ 9 → GO TO INTRODUCTION 16

PA.7 When was the last time that your blood cholesterol was measured?
• Within the past 12 months _ 1
• 1-5 years ago _ 2
• More than 5 years ago _ 3
• don't know _ 8
• refusal _ 9

As an alternative, the questions below are from EHRM (including a question on treatment):

HCL1 When was your blood cholesterol last measured? |__|
1 = Within the past 12 months
2 = 1-5 years ago
3 = Not within the past 5 years

HCL2 Have you been told by a health professional in the past year (12 months) that you have raised (elevated) blood cholesterol? |__|
1 = Yes
2 = No
3 = Uncertain

HCL3 Are you currently taking medication prescribed by a doctor to lower your blood cholesterol level? |__|
1 = Yes
2 = No
3 = Uncertain

HCL4 Has a doctor in the past year ordered you to change your way of life, in order to lower your total blood cholesterol? |__|
1 = Yes
2 = No
3 = Uncertain

Diabetes

Introduction 16
Now I would like to ask you some questions about your blood sugar (glycaemia).

PA.8 Has your blood sugar ever been measured?
· Yes _ 1
· No _ 2 → GO TO FILTER 5
· don't know _ 8 → GO TO FILTER 5
· refusal _ 9 → GO TO FILTER 5

PA.9 When was the last time that your blood sugar was measured?
· Within the past 12 months _ 1
· 1-5 years ago _ 2
· More than 5 years ago _ 3
· don't know _ 8
· refusal _ 9

In addition, the following 2 questions from EHRM on awareness and treatment of diabetes are also recommended.

DIAB1 Have you ever been told by a doctor that you have diabetes? |__|
1 = Yes
2 = No
3 = Uncertain

DIAB2 Are you currently taking insulin or pills to control diabetes? |__|
1 = Yes
2 = No
3 = Uncertain

7.6.6 Quality control

Equipment
Check the expiring date of the vacutainers.

Procedures
Field personnel should be observed during surprise visits to the examination sites, to verify compliance with the protocol. A previously agreed upon check list should form the basis for these observations. Blood samples should be traceable to the individual phlebotomist. The compliance of the phlebotomist with the exclusion criteria for blood collection should be checked by cross validation with questionnaire data. Phlebotomists may also be assessed by the number of failed blood collection procedures.

7.7 Laboratory procedures

7.7.1 Laboratories

All laboratory procedures should be carried out only in accredited medical chemistry laboratories.

7.7.2 Analytical procedures

Good direct enzymatic methods are available for a total, LDL and HDL cholesterol assay as well as for glucose. These can be used in automated or manual methods with inexpensive instruments.
The Centres for Disease Control and Prevention (CDC) has a certification program for clinical diagnostic products for cholesterols [REF: Web].

7.7.3 Quality control

Internal quality control of laboratory analyses
For each type of assay the laboratory has to obtain quality control material. Particularly important is the secondary calibrator, which should be real human serum or plasma in the same form as the survey blood samples. These secondary calibrators should be traceable to an internationally recognized reference method. Each standard (calibrator) should be run at least in duplicate. The linearity over the usual working range of the assay should be tested and checked repeatedly during the study. The linearity should be checked with at least three standards in each run.

External quality control of laboratory analyses
External quality control is arranged by internationally recognized reference laboratories that distribute batches of samples of various concentrations for each assay. The participating laboratory is blinded to the concentration of the analyte. Bias and standard deviations of the results of the participating laboratory serve as a measure of performance. Laboratories should participate in the external quality control scheme for the duration of the study. (No such external quality control is currently available for the European HESs, but a recommendation for its establishment is made in Chapter 10.)

7.8 Physical Functioning

7.8.1 Upper body functioning

Handgrip strength

Hand grip strength is often used as an indicator of overall muscle strength in population studies. In addition it has been shown to be powerful predictor of mortality. A wide range of instruments and measurement protocols are available to measure hand grip strength. Hydraulic instruments (dynamometers) are the most widely used and recommended instrument.

Aim of the test
The aim of the hand grip measurement is to measure the strength of the dominant hand (writing hand). This should be asked before the measurement. If the participant is unable to use the dominant hand the test should be performed by using the non-dominant hand. This information and also the reason not to be able to use the dominant hand should be reported.

Age
Handgrip strength is recommended to be measured from all 30 years and older [ii].

Exclusion criteria
People with swelling or inflammation, severe pain or injury (e.g. fracture) and those with surgery to the hand in the last 6 months should not take the grip strength test. In addition bad arthritis and rheumatology may prohibit the measurement. Also dementia and some other cognitive problems may prohibit the measurement (e.g. if the participant does not understand the instructions). The reasons not to conduct the test should be reported.

Time of measurement
The measurement of grip strength requires approximately 3 to 5 minutes performing.

Equipment
Standard handheld dynamometer (hydraulic instruments)

Measurement protocol
Testing position
A standard position for testing adapted from the recommendation of the American Society of Hand Therapists is recommended. The participant should

- Sit in a straight-backed chair
- Feet flat on the floor
- Shoulders adducted in neutral
- Arms unsupported
- Elbow flexed at 90 degrees (from the dominant hand)
- Forearm rotation neutral
- Wrist 0-30 degrees dorsiflexion and 0-15 degrees ulnar deviated
- The arm which is not measured can be on the body side or in on one's knees.

The dynamometer should be placed to the hand so that the wrist is in neutral position (slight dorsal flexion). The grasp is some what same as when giving handshake. Variations from this position significantly influence results.

Adjustment of the device
Dynamometers are usually variable hand span instruments with different positions for measurement (usually 5 different positions). The device should be adjusted to fit to the size of the hand of the participant so that the second joint of the forefinger should be in 90 degree flexion. If the size of the device is too small the hand will go too fist. Before starting the measurement the participant should be asked that the grasp feels natural size.

Instructions
Illustrate the use of the instrument to the participant prior to testing. When the right testing position is found the test can be started.

The participant is asked to squeeze the dynamometer with as much force as possible, being careful to squeeze only once for each measurement. Be sure that the body is not used in the measurement (e.g. the trunk must be in place). The tester needs to encourage the participant the do they best during the measurement.

Say to the participant: 'The *test is to begging…Now! Squeeze! Squeeze! Squeeze! Good you can stop now and rest*'.

Each squeeze should stand 3 to 5 seconds. Encouragement affects to the results and thus it should be kept the same for all participants. Three trials should be made with a pause of about 10-20 seconds between each trial to avoid the effects of muscle fatigue.

Record the result of each trial to the nearest pound or kilogram. If the difference in scores is within 3 kgs., the test is complete. If the difference between any two measures is more than 3 kgs., then repeat the test once more after a rest period. Use the best 3 measurements (i.e. the highest three) in your data report.

When a 4th measurement is taken with the hand grip (when any of the 3 measurements are 3 kg apart) be sure the outlier (THE LOWEST VALUE) is crossed off with your initials so that the 3 HIGHEST measurements are clearly indicated for data entry.

Record also
Dominant hand right / left
Reasons not to perform the test:
Reason to not to use the dominant hand:

Open questions
→ Is it ok to measure only from dominant hand? Or should we measure both hands?

7.8.2 Lower extremity

7.8.2.1 Walking speed test

Walking speed has been shown to be a good predictor of nursing home admission, morbidity and mortality. In addition it has been shown to be a good predictor of disability outcome. Gait speed is simple performance based measurement, easily and quickly assessed in clinical and research settings.

Aim of the test
The aim of the walking speed test is to measure the *normal walking speed* in the corridor of 4 meters *(*Guralnik et al 1994; 2000, Simonsick et al 2001) without any check. The starting line and finishing-line of the distance is marked on the floor by tape.

Age
Walking speed is recommended to be measured from all 50 years and older.

Exclusion criteria
Walking speed test is not measured from wheelchair bound individuals or people who have severe difficulty to walk or keep a standing position. NOTISE! Walking aids (canes, walkers etc.) that are used in normal walk in daily activities are allowed. However, the use of these on the test needs to be reported. Also dementia and some other cognitive problems may prohibit the measurement (e.g. if the participant does not understand the instructions). The reasons not to conduct the test should be reported.

Time of measurement
The measurement of walking speed will take approximately 1 minute.

Equipment
Stopwatch is needed to measure the time of the walk and tape to mark the starting- and finishing-lines of the test e.g. mark on the ground the distance that should be walked (4 meter[iii]).

Measurement protocol
Ask the participant to walk 4 meter distance in normal walking speed. The time will be recorded to the nearest 0,1 second. The timing of the test will be started on when the tester says ‘Now’ and ended when the trunk of the participant over the finishing-line.

If the participant is able to walk normally and the risk of falling or banging into something is minimal the tester can take the time at the finishing-line of the test. If the walk of the participant is unsure or unsecure the tester should walk by the side of participant.

When a walking stick or other devices (cane, walker etc.) are used during the test, this should be recorded.

Instructions
Instruct the participant to ‘*Walk to other end of the course at your usual speed, just if you were walking down the street to go to the store. You should start from here (show the line) and walk over the finishing-line of the test. I will take the time it takes to walk. Are you ready?....Go’*

Record also
Did the walking speed test
0 succeed with out walking aids
1 succeed wit a help of walking aid
2 did not succeed, 1 minute overrun
3 did not succeed because of security reasons

The reason why the test was not conducted:

Open questions
- → Should we measure also maximal/rapid walking speed e.g. both normal and maximal walking speed?
- → If only normal walking speed is measured should the test be conducted twice and take the faster of the two to be used for analyses?

7.8.2.2 Test of standing balance

Balance and co-ordination are needed to carry out successfully every day loco motor function at reasonable speeds and to prevent falls.

Aim of the test
The aim of the test is to measure the standing balance in three different positions including semi-tandem, side by side or full tandem stands (Guralnik et al 1994).

Age
Standing balance (Guralnik et al 1994) is recommended to be measured from 60 years and older (Era et al 2006).

Exclusion criteria
Standing balance is not measured from wheelchair bound individuals or people who have severe difficulty keep a standing position (for example fracture in leg). Also dementia and some other cognitive problems may prohibit the measurement (e.g. if the participant does not understand the instructions). The reasons on not to conduct the test should be reported.

Time of measurement
The measurement of semi-tandem and side by side or full tandem stand will take approximately 5 minutes.

Equipment
Stopwatch is needed to measure the time of standing in a certain positions.

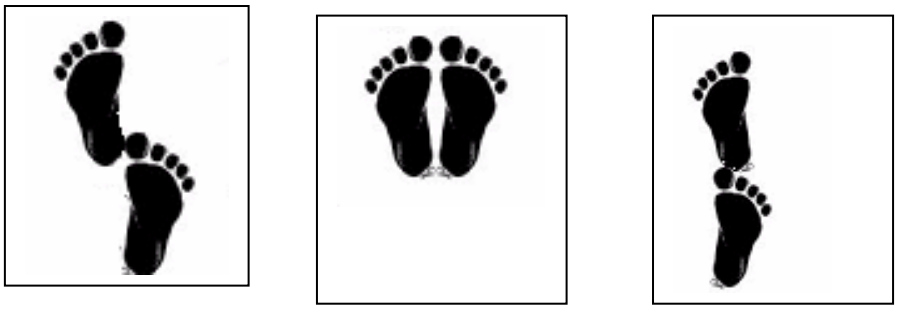
Measurement protocol
Test of standing balance include semi-tandem and side-by side or tandem stands. For each stand, the tester first demonstrate the task, then support one arm while participant positioned their feet and after that asks if the participant is ready to start the test, then release the support

and start the timing. The timing will be stopped when the participant move their feet or grasp the tester for support, or when the 10 seconds will be elapsed.

Each participant starts the test from semi-tandem stand in which the heel of one foot is placed to the side of the first toe of the other foot. The participant can choose which foot to place forward. Those unable to hold the semi-tandem position for 10 seconds will be evaluated with feet in side by side position. Those able to maintain the semi-tandem position for 10 seconds will be further evaluated with feet in full tandem position, with the heel of one foot directly in front of the toes of the other foot (see picture 7.8.3.1).

Picture 7.8.2.1. Standing balance positions

1) Semi-tandem 2a) Side by side 2b) Tandem



Instructions

1) Semi-tandem

Explain and demonstrate the semi-tandem stand to the respondent. Stand to the side of the respondent. Support one arm while participant positioned their feet and after that asks if the participant is ready to start the test, then release the support and start the timing. Press the start button to start the stopwatch as soon as the respondent gets into the position and is free of support. Stop the stopwatch and say '*Stop*' after 10 seconds or when the participant steps out of position or grabs your arm. Record the result succeeded / un-succeeded

2a) Side by side

Participant unable to hold the semi-tandem position for 10 seconds will be evaluated with feet in side by side position. Explain and then demonstrate the side by side stand to the respondent. Stand to the side of the respondent. Support one arm while participant positioned their feet if needed and after that asks if the participant is ready to start the test, release the support and start the timing. Press the start button to start the stopwatch as soon as the respondent gets into the position and is free of support. Stop the stopwatch and say '*Stop*' after 10 seconds or when the participant steps out of position or grabs your arm. If the participant is successful record this.

2b) Tandem

Those able to maintain the semi-tandem position for 10 seconds will be further evaluated with feet in full tandem position, with the heel of one foot directly in front of the toes of the other foot. Explain and then demonstrate the full tandem stand to the respondent. Stand to the side of the respondent. Support one arm while participant positioned their feet and after that asks if the participant is ready to start the test, then release the support and start the timing. Press the

start button to start the stopwatch as soon as the respondent gets into the position and is free of support. Stop the stopwatch and say '*Stop*' after 10 seconds or when the participant steps out of position or grabs your arm. Record the result succeeded / un-succeeded

In each position if the participant is not capable to do this test does not attempt the movement. If the participant is unable to hold the position for 10 seconds, record the time in seconds. If the respondent did not attempt the measure, record the reason.

Open questions
→ Should we use some more discriminating test than Guralnik's (1994) such as balance platform 'foam pad, eyes closed' test (Curb et al 2006). This test has been used also in the EPES and NHANES. It could be recommended to 30 years and elderly?
→ Guralnik's test has been shown to be eligible only for elderly population (Era 2006)

7.8.2.3 Unassisted single-leg stand

Aim of the test
The test measures the standing balance as well as multiple domains of functioning of the participant (Curb et al 2006, Simonsick et al 2001)

Age
Unassisted single leg stand is recommended to conduct for all 30 years and older

Time of measurement
The total measurement will take about 3 minutes.

Equipment
Stopwatch

Exclusion criteria
One leg stand is not measured from wheelchair bound individuals or people who have severe difficulty keep a standing position (for example fracture in leg). Also dementia and some other cognitive problems may prohibit the measurement (e.g. if the participant does not understand the instructions). The reasons on not to conduct the test should be reported.

Measurement protocol
The leg raises should be performed adjacent to a stable surface, e.g. a table or wall near and the nurse should be positioned to the other side of the participant. The participant is expected to keep the one leg standing position up to the 30 seconds. The respondent should take their foot off the floor, and may hold it in any position which does not involve hooking around or touching the other leg for support.

Explain and then demonstrate the side by side stand to the respondent. Stand to the side of the respondent. Support one arm while participant positioned their feet if needed and after that asks if the participant is ready to start the test, release the support and start the timing.

Instructions

'*Now I will show you the NEXT movement. I want you to try to stand on one leg, whichever one you want, and raise the other leg off the ground a few inches e.g. near to your angel. Stand for as long as you can until I said Stop – I will stop you at 30 seconds. You may use your arms, bend your knees or move your body to maintain your balance, but try not to move your feet. Try to hold the position until I tell you to stop. Do you feel that it would be safe to do this?*

If the respondent says 'no', do not conduct the test. If the respondent says it is safe ask the respondent to stand up. Stand to the side of the respondent. Say: 'ready, begin.' Press the start button to start the stopwatch as soon as the respondent raises one foot off the ground and is free of support. Stop the stopwatch and say 'stop' either a) when the raised leg touches the floor as the respondent loses their balance or b) after 30 seconds, whichever happens first. Record the outcome on the collection form. If the participant is unable to hold the position for 30 seconds, record the time they held the position for.

Open questions
-

7.8.2.4 Timed Chair stand test

Aim of the test
Timed chair stand test measures the ability to rise from a chair (termed chair stand). It is a test of lower extremity and central strength, although other functional domains are also involved such as endurance. (Guralnik et al 1994, Curb et al 2006). The test involves measuring the time required to stand up from a chair and sit down in a chair five and ten times without using arms.

Age
Timed chair stand test can be conducted for all 30 years and older.

Time of measurement
The total measurement will take approximately 2 to 3 minutes.

Exclusion criteria
Timed chair stand test is not measured from wheelchair bound individuals or people who have severe difficulty keep a standing position or walk and for those unable to stand up without help (for example fracture in leg). Also dementia and some other cognitive problems may prohibit the measurement (e.g. if the participant does not understand the instructions). The reasons on not to conduct the test should be reported. The use of walking aids is not permitted in this test.

Equipment
Timing of the test requires a stopwatch and a standard high armless straight-backed chair (height 45 cm). If an ideal chair is not available, the following criteria for chair selection should be used in the order given:

a) Armless, rather than with arms
b) Firmness; the firmer the better
c) Do not use beds, cots, folding chairs, garden chairs, chairs with wheels or chairs that swivel.

Measurement protocol
A straight-backed chair should be placed next to the wall. Participant's feet should touch the floor when they are sitting (e.g. chair should not be too low or high). Participants are asked to fold their arms across their chest and stand up from the chair **one time**. If successful, participants will be asked to **stand up and sit down five to ten times** as quickly as possible. The timing will be started from the sitting position and end to the final standing position at the end of the fifth and tenth stand. Stand next to the participant to be able to provide assistance is s/he loses his/hers balance.

If the participant do not completed the single chair rise without using his/her arms, they are not eligible to attempt the repeated chair rises. This and the reason for not to complete the test, should be reported.

Instructions
Single chair stand
Explain and demonstrate the single chair stand to the participant. If the participant can not rise without using arms say 'Try to stand up by using your arms'. Record the outcome of single chair stand. If the participant refuses to try the single chair stand or is unable to stand up on his/hers own without using arms to push off, the do not attempt the repeated chair stand.

Repeated chair stand
Ask the participant to resume the sitting position s/he was in just before standing up, with their feet resting on the floor and their arms folded across the chest. Explain the repeated chair stand. When the participant is properly seated, say 'ready, begin'. Start the stopwatch as soon as you say 'ready, begin'. Count out loud as the participant rises each time, up to ten times. A rise is complete when the respondent is fully standing with their back straight. NOTISE! When respondent completes the fifth rise, press the split timer on the stopwatch. Continue counting out loud. When the respondent has straightened up completely for the tenth time, stop the stopwatch"

Stop if the participant becomes too tired or short of breath during the repeated chair stands. Also stop:

- If the participant uses his/her arms
- After 1 minute, if the participant has not completed all the rises
- At your discretion, if you are concerned for the participant's safety

If the participant stops and appears to be fatigued before completing the ten stands, ask *Can you continue?* If the participant says "Yes," continue timing until 60 seconds has elapsed. If she says 'no' stop the stopwatch and record the number of completed stands without using arms. Be careful to enter the time from the first five stands first, before retrieving the time for the 10 stands from the stopwatch's memory.

Open questions
→ Is the 5 standing needed? Or is it only enough to do the 10 chair stand?

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7.9 Ankle arm index

Age: 40 years and older
Time measurement: the measurement will take about 5-10 minutes(?).
Equipment:
Protocol.
There is no standardized protocol for measuring the ankle arm index.
Since the introduction of the AAI a wide variety of methods of AAI measurements and calculation have been used in studies. Klein et al. made an analysis of all the methods used to asses AAI and its normal range and to recommend a standardized method to asses AAI based on there analysis[iv].

Position of the participant:
The supine position seems to be the position of choice to assess AAI because the influence of height of the subject and his or her blood column pressure on AAI may be prevented only in this position.

Cuff
Ideally, the cuff width should be at least 1.5 times the diameter of that part of the extremity where the pressure is being measured, and the size of the cuff should be adjusted in obese patients or in patients with odd shaped arms or ankles.

Method of detection of the pulse in arm and leg
The use of a pencil-Doppler should be considered the method of choice to detect the brachial pulse as this was already done in half of the reviewed studies. Measurements by Doppler device were proven at high, medium, and low blood pressures to correlate with systolic pressure measurement obtained by conventional methods.

Choice of arm and leg for measurement
The blood pressure should be taken at both arms and both legs to rule out serious differences and using that of the left arm to calculate the AAI denominator with the left leg.

Protocol (concept)
1. Systolic blood pressures are obtained using cuffs, a Doppler, and a cuff inflation device (Sphygmomanometer).
2. Apply cuffs to each arm above the elbow.
3. Apply cuffs to each ankle.
4. Locate an arterial signal in the arm by listening with the Doppler at the brachial, radial or ulnar area.
5. Inflate the cuff with to a pressure 20 - 30 mmHg above the audible arterial Doppler signal.
6. Slowly deflate the cuff and listen for the return of blood flow to the distal part of the limb. Note the pressure reading when the first arterial signal is heard. This is considered the systolic pressure at the level of the cuff. Record this on the form.
7. Both arm systolic pressures are taken to determine the systemic blood pressure. The higher of the two pressures will be used in the calculation of the ratios
8. For ankle measurements follow the procedure as described above in steps 4 through 6. Monitor either the dorsalis pedis or posterior tibial artery, whichever gives the strongest signal. The peroneal artery may be used if one or both of the previous sites are not available. Record this on the form.

9. If resting pressure measurements need to be repeated, the cuff should be fully deflated for about a minute prior to each inflation. This is to prevent the effects of induced reactive hyperemia.

Interpretation

The ankle / arm index is calculated by the dividing the ankle pressure by the higher of the two arm pressures. (If there were a subclavian stenosis present unilaterally, there would be a systolic pressure difference of 15-20 mmHg or greater, with the affected side being lower.) Compute the ankle/arm index by dividing each ankle pressure by the HIGHEST brachial systolic pressure

7.10 Quality assurance

7.10.1 Training

All fieldworkers will receive a training before the actual work in the field. Training will include an instruction session, in which protocols are reviewed and discussed, and measurement are practised Possible difficult situations that might arise during the field are presented and solution strategies are discussed. Also the quality control procedures during and after the survey will be presented

Waist hip circumferences
Practice measurements are made under supervision. The performance may be evaluated on the basis of:

- Placement of tape
- Variability between duplicated measurements of a number of subjects.
- Comparison with repeated measurements of a number of subjects by different measures
- Terminal digit preference

7.10.2 Quality control

For checking the quality of the measures, the distribution of the height, weight, waist and hip circumferences terminal digit should be checked routinely. It is important to avoid digit preference, for e.g. 0 or 5 at the end. If a measure has not been performed, a reason should be mentioned on the form.

If problems are detected, they need to be discussed with the individual measurer immediately. Feedback to the measurers about the quality of their performance can help to improve the quality of the field work. If errors persist, the measurer should be retrained .

During extended surveys, a sessions to refresh the quality aspects for all measurers every three months is a desirable practice.

Auditors should make surprise visits to the examination sites and observe the measurers, recording the compliance with the protocol in performance evaluation forms that can later be used to review the audit with the measurers. The auditors could also act as guest participants and take part in a number of measurements.

Blood samples should be traceable to the individual measurer. The compliance of the phlebotomist with the exclusion criteria for blood collection should be checked by cross validation with questionnaire data. Phlebotomists may also be assessed by the number of failed blood collection procedures.

7.10.3 Quality assessment after the survey

It is important to check the overall quality of the anthropometric measurement. The quality assessment should include the item response rates for height, weight, and waist-hip circumference. And the distribution of terminal (decimal) digits and the distribution of terminal digits of full kilograms for weight measurement.

The data should be checked as soon as possible after the data collection for:

- outlandish values, i.e. for values which have not been defined, and also for values which are possible but rare (e.g. BMI of 40 kg/m2);
- consistency between the values of different data items e.g. the difference between systolic and diastolic blood pressure);
- Completeness, i.e. that all data items have been recorded and no records have been missed.

A visual checking of the key items can be done at the interview or examination site even if paper forms were used, and extensive checking should take place as soon as the data have been computerized. When potential errors are detected, they should be investigated for correctness, and corrected only if it is found that they really are errors. It is a good practice to authorize only those who have made the errors to correct them, because they are usually in the best position to say if there really is an error, and they are usually the only ones who know the correct value. Each error and its possible correction should be documented.

The frequency of errors, which were not possible to solve should be documented. In addition, the results of the quality control during the data collection, any deviations from the survey protocol, and any other information which may be relevant in the interpretation of the results should be documented too. Knowledge of these issues is essential to those who analyze the data and interpret the results.

Appendix 1 Example of the blood collection recording form.

Participant's identification code |__||__||__||__||__||__|

Blood collection

Person taking blood sample(s) (identification code) |__||__|

Date (ddmmyyyy) |__||__|.|__||__|.|__||__||__||__|

Time of day (hhmm) |__||__|:|__||__|

Time of the last meal |__||__|:|__||__|

Position of subject during the blood collection |__|
1 = sitting
2 = supine

Arm used for blood sample (if blood collection failed, code the arm where the last attempt was made) |__|
1 = left
2 = right

Number of tubes received
1 = all
2 = only |__| tubes
3 = none

Reason for no blood collection

- Participant refused
- Vene could not be found / difficult to take a blood sample

Appendix 2 Example of the blood handling recording form.

Participant's identification code |__||__||__||__||__||__|

Blood collection

Person handling blood sample(s) (identification code)	|__||__|
Date (ddmmyyyy)	|__||__|.|__||__|.|__||__||__||__|
Time of day of centrifuging (hhmm)	|__||__|:|__||__|
Time of day (hmm) blood samples in freezer	|__||__|:|__||__|
Hemolyse?	Yes |__| No |__|
Number of serum storage tubes	|__|
Number of plasma storage tubes	|__|
……..	|__|

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