DOCUMENTATION

for

MUSCULOSKELETAL HEALTH and FUNCTION DATA

in

MIDUS 3
BIOMARKER PROJECT
(P4)

University of Wisconsin ♦ Institute on Aging
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INTRODUCTION

This document provides an overview of the musculoskeletal health and function data collected in the MIDUS 3 (M3) Biomarker Project (P4) data. It describes the measures obtained and provides comprehensive information regarding methods used to collect the data. Administrative and computed variables are identified and information about the construction and usage of these variables is included.

Data users are also encouraged to review the Biomarker (P4) Readme Data File Notes. It provides information about naming conventions, as well as administrative and filter variables included in the data file. The Readme also includes information about how we handled missing values and other issues that arose over the course of the study. For example, there are instances when variables were added or sections of an instrument were expanded for data entry purposes to accommodate additional information provided by the respondent.

This document will be periodically revised and updated as more information is gathered, and researchers continue to work with the MIDUS Biomarker data. If there are suggestions or comments, please submit a message through the MIDUS HelpDesk (http://midus.wisc.edu/helpdesk.php).

Table of Contents

SECTION A: OVERVIEW OF DATA FILE AND COLLECTION PROTOCOLS

The Biomarker Project (P4) includes multiple types of data regarding musculoskeletal health (from the indicated sources):

- Bone Turnover measures from serum.
- Questionnaire Data
- Dual Energy X-ray Absorptiometry (DXA) Scans
- Bioelectrical Impedance Spectroscopy
- Bioelectrical Impedance via BodyComp Scale
- Muscle Function Assessments (Jump Mechanography/Balance)

As described in the "MIDUS 3 Biomarker Project (P4) Readme Data File Notes" the MIDUS naming convention organizes variables according to data type or the method used for data collection. We have followed this convention with respect to the musculoskeletal health data, thus researchers using bone turnover, DXA, impedance, and questionnaire data will need to pull variables from different sections of the data file. See below for brief guidance on where each kind of bone data is located in the data file.

Questionnaire, blood assay, and DXA data are obtained at all three sites as described below. Bioelectrical impedance is assessed via different methods at the UW and the other two sites (UCLA, Georgetown). Due to limitations in equipment availability the muscle function assessments are only completed at UW. The following provides details about the development of the overall bone/musculoskeletal health protocol, as well as additional details about the measures.

DATA DOCUMENTATION

BONE TURNOVER

The bone turnover assays use samples that are processed through the Biocore, so these variables can be found with the other blood assay result data. Details about the blood collection and processing protocols can be found in the "Documentation for Blood, Urine and Saliva Data."

Following the MIDUS variable naming convention, the first three characters of these variables are "C4B."

QUESTIONNAIRE DATA

At MIDUS 2 a standalone bone questionnaire was developed and administered by project staff during the clinic visit. Beginning with the MIDUS Refresher, items from the Bone Questionnaire were integrated into the Medical History Interview administered during the visit. See the Study Summary for information about how those items were integrated as well as other information about the interview. Since these items are now in the Medical History the variable names begin with the unique 3-character set "C4H" used for that instrument.

DENSITOMETRY SCANS

There are two primary types of DXA scans provided by MIDUS: Bone density assessments, and whole body scans measuring 3 compartment total body composition (bone, fat, and lean). This allows the data to provide

information on both bone health and overall obesity. As a supplement to the bone data, lateral vertebral fracture assessment (VFA) scans provide a complement to self-report of clinical fracture. VFA data are reported as evidence of moderate or severe vertebral fracture, with number of affected vertebrae based on clinical interpretation of the scans.

DXA scans are performed at all three sites, but there are important site-specific differences:

1. The University of Wisconsin (UW, Site 2) is the central coordinating site and is responsible for providing quality control and analyzing scans from all sites.
2. UW uses a GE (formerly Lunar) DXA system (iDXA) but UCLA and Georgetown use a Hologic system. Due to variation in instrument technology, significant BMD differences in mass measurement exist between the systems (Lunar values ~10% higher than Hologic). Consequently, we created two sets of mutually exclusive variables, one for Hologic and one for GE data. UW cases only have GE data, while UCLA and Georgetown cases only have Hologic data.

DXA scan protocols for the GE and Hologic systems are included in Section B below.

IMPORTANT Analysis Notes: The BMD values from the GE and Hologic systems are not directly comparable, as they generate different values (grams/cm2) for the same amount of bone, but there is good agreement between the T-scores generated by these systems. Given these differences, the standard in the field is that BMD values from the two systems are not combined as a variable, but instead T-scores are used in analyses utilizing bone density scan data obtained from both systems. T-scores are derived at the lumbar spine using manufacturer's normative databases and NHANES III database at the hip. This approach results in similar T-scores between systems at all sites. Male normative databases are used to derive T-scores in men and female databases in women. For more information, see the following citations:

Hanson, J. (1997). "Letter to the Editor Standardization of femur BMD." Journal of Bone and Mineral Research 8:1316-1317.

Kiebzak, G., E. M. Lewiecki et al. (2004). "Good diagnostic agreement using T-scores between Delphi and Prodigy." Journal of Clinical Densitometry 7:229.

Kiebzak, G.M, N. Binkley et al (2007). "Diagnostic agreement at the total hip using different DXA systems and the NHANES III data base." Journal of Clinical Densitometry 10:132-137.

For data analysts interested in using just proximal femur data the following citation provides equations for converting Lunar data to Hologic for women.

Lu, Y., T. Fuerst, et al (2001). "Standardization of bone mineral density at femoral neck, trochanter and Ward's triangle." Osteoporosis International 12:438-444.

For body composition data, conversion equations are available for BMC, BMD and percent fat in the citation below.

Shepherd J, Fan B et al (2012). "A multinational study to develop universal standardization of whole-body bone density and composition using GE Healthcare Lunar and Hologic DXA systems."

The DXA variables appear in the data file immediately following the Medical History Interview data. The variable names begin with "C4D" and include the following measures:

1. Bone Density:
    a. Spine - Bone mineral density (BMD) for L1-L4, T-score for L1-L4
    b. Femur – BMD and T-score for the left and right femur neck and total femur
    c. Forearm – BMD for the 1/3 radius, T-score for 1/3 radius
    Note – T-scores are released for all participants regardless of menopausal status for women and age for men.
2. Vertebral Fracture: based on a trained clinician reviewing approximately L5-T4 from a DXA acquired lateral spine scan and applying the Genant visual semi-quantitative method
    a. Moderate or severe vertebral fracture observed?
    b. If yes, how many fractures?
3. Body Composition – measures of bone, fat, and lean mass in grams for:
    a. Arms – right, left, both
    b. Legs – right, left, both
    c. Trunk – right, left, both
    d. Total – right, left, both
    e. Android
    f. Gynoid

It is noteworthy that not all the variables are included for GE and Hologic. To reduce the likelihood of transcription or formula errors, only variables that are exported directly from the software were coded. Consequently, Hologic does not have the combined variables for only arms or legs. Again, as noted above, the mass measurements are not equal across the two instruments and should not be pooled to assess raw mass.

The data set also includes the following more administrative variables:

- C4DAVAIL – categorical variable indicating whether there are Bone Mineral Density data available for a given case.
- C4DSTYPE -The scanner system (GE, Hologic) used to collect the data
- Region specific variable indicating the side (left or right) scanned for the radius.
    - C4DLRSIDE – Lunar radius side scanned, 1=Right, 2 = Left
    - C4DHRSIDE – Hologic radius side scanned, 1=Right, 2 = Left
    - The similar left/right side variables for femur measures at MR1 have been discontinued, because both left and right femur data is now provided.
- C4DTBAVAIL – categorical variable indicating whether there are Body Composition data for a given case

BIOELECTRICAL IMPEDANCE ASSESSMENTS

As noted above, the increase in obesity in the population and increasing interest in sarcopenia, prompted interest in total body composition assessment. DXA was selected, as it is a well-accepted method to assess body composition and is included in most consensus sarcopenia definitions, however, it is not without limitation. Specifically, DXA measured lean mass is largely a measurement of water, not true muscle mass. Although this is commonly used as a surrogate of muscle mass, it is truly a measure of the compartment not comprised of fat or bone mass, therefore DXA-lean mass provides an overestimation of muscle mass. Consequently, we sought to add an additional measurement that potentially may better assess muscle mass.

Single frequency bioelectrical impedance analysis (BIA) is often assessed in large national research studies, such as MESA (Multi-Ethnic Study of Atherosclerosis) using body comp scales. However, this single frequency measurement has a similar limitation to DXA, in that it does not differentiate muscle from lean mass. A multi-frequency approach, in the form of bioelectrical impedance spectroscopy (BIS) likely offers a better surrogate. In this approach, high frequency current travels through the fluid inside and surrounding the cell, taking a measurement of all fluid. The low frequency currents travel in the fluid surrounding the cells, generating a measure of extracellular fluid (ECF). Therefore, this technology allows for assessment of both ICF (intercellular fluid) and ECF.

The equipment and software for obtaining BIS data was available at the UW site, a BodyComp scale was available at UCLA and Georgetown. Thus both methods of measuring bioelectrical impedance are included in the Biomarker protocol, depending on the site. Details about these two bioelectrical impedance measurement procedures are provided below.

The BIS variables appear in the data file immediately following the DXA data, the BIA variables immediately follow the BIS variables. All the bioelectrical impedance variable names begin with "C4I" regardless of method. In addition to the bioelectrical impedance variables described below the data file also includes the following flag/filter variables:

- C4IELIG – categorical variable indicating whether a given case is eligible for the body impedance assessment, including reasons for not eligible (i.e. pacemaker, etc.).
- C4IBISAVAIL – categorical variable indicating whether there is BIS data available for a given case
    - This variable will be INAPP for all Georgetown and UCLA participants.
- C4IBIAVAIL – categorical variable indicating whether there is BI data available for a given case.
    - For UCLA and Georgetown: for cases that meet eligibility criteria, but have missing data, it is always due to printer problems.
        - If the protocol was run but the report generated by the BI system could not be printed then "MISSING" is assigned
        - If the protocol was not run due to known printer problems that had not yet been fixed, then "INAPP" is assigned.
    - This variable will be INAPP for all UW participants.

The references listed below outline the techniques and refer to many of the variables captured in MIDUS.

Yamada Y, Watanabe Y, et. al. 2013 Comparison of single- or multifrequency bioelectrical impedance analysis and spectroscopy for assessment of appendicular skeletal muscle in the elderly. J Appl Physiol, 115:812-8.

Yosuke Y, Buehring B, et. al. 2017 Electrical Properties Assessed by Bioelectrical Impedance Spectroscopy as Biomarkers of Age-related Loss of Skeletal Muscle Quantity and Quality. J Gerontol A Biol Sci Med Sci, 72:1180-1186.

Kuchnia AJ, Yamada, Y. 2018 Combination of DXA and BIS body composition measurements is highly correlated with physical function-an approach to improve muscle mass assessment. Arch Osteoporos, 13:97, 10.1007/s11657-018-0508-7.

Bioelectrical Impedance Spectroscopy *(NEW)*

Bioelectrical Impedance Spectroscopy (BIS) is performed using the ImpediMed SFB7 (Eight Mile Plains, QLD, Australia). These data were collected only at UW and added to the Biomarker protocol at the Refresher and continued into M3. Two measurements were acquired for each site (total body and left leg). The reported data are a mean of these measurements. When one of these measurements was excluded due to technical inadequacy, only the technically valid measurement was used. For segmental measurement of the left leg, leg length was measured from the most lateral point on the greater trochanter to the most distal tip of the tibia from the whole body DXA images using the ruler tool. Segmented measurements for bilateral arms and legs were added at M3 as described by Yamada (Eur J Appl Physiol. 2009;107:135-44). Leg limb length was measured as described for left leg, arm length was the addition ulna and humerus length, as measured from the whole body scans. Specifically, a ruler was drawn from the ulnar styloid process to the most proximal tip near the elbow, and the distal center of the humerus to the most proximal point of the humeral head.

The BIS acquisition protocol appears in Section B below.

The BIS variables appear in the data file immediately following the DXA bone density and body composition data. The variable names begin with "C4I" and include the following measures:

1. Whole Body Measurements:
    a. Software generated fat free mass (FFM)
    b. Percent fat free mass (FFM/total body mass)
    c. Instrument measured extracellular fluid (ECF)
    d. Instrument measured intracellular fluid (ICF)
    e. Calculated percent intracellular fluid (ICF/ICF+ECF)
    f. Calculated total body water (ICF+ECF)
    g. Calculated ICF proportion of weight (ICF/total body mass)
2. Segmented BIS Measurement: For purposes of these equations, ECF = instrument measured extra cellular resistance (Re) and ICF = instrument measured intracellular resistance (Ri).
    a. Both Arms
        i. Extracellular fluid index ((arm length*2)2/ECF)
        ii. Intracellular fluid index ((arm length*2)2/ICF)
    b. Both Legs
        i. Extracellular fluid index ((leg length*2)2/ECF)
        ii. Intracellular fluid index ((leg length*2)2/ICF)
    c. Left leg
        i. Extracellular fluid index (leg length2/ECF)
        ii. Intracellular fluid index (leg length2/ICF)

BIOELECTRICAL IMPEDANCE VIA BODYCOMP SCALE *(NEW)*

Bioelectrical impedance (BIA) was assessed using the Body Comp Scale manufactured by Valhalla Scientific. This data was collected at UCLA and Georgetown, added to the Biomarker protocol at the Refresher and continued into M3. In contrast to BIA scales that might be found in health clubs, this scale is more standardized and has been employed by other large national research studies. Participants stand on the BodyComp scale (which looks like a weight scale) without shoes or socks and grip two metal handles, so that a safe, small, unnoticeable electrical current can pass through the body. The algorithms used by the BodyComp Scale calculations are proprietary according to the manufacturer Valhalla Scientific (http://www.bodycompscale.com/faqs/, section titled "What is Bioelectrical Impedance Body Composition

Analysis and Ohms Modulation Logic?"). The results of the BIA are printed and the values subsequently entered in the study database. Note that if height or age are entered incorrectly, the subsequent BIA measures will not be correct and are flagged in the data.

Unless otherwise indicated, the report produced by the device calculates the following measures as percent of body weight, in pounds and in kilograms:

- Current body weight (pounds and kilograms only)
- Total body fat
- Fat-free mass
- Total body water (percent of body weight, pounds, liters)
- Muscle mass
- Body mass index (BMI; kg/m2)
- Target weight range (minimum)
- Target weight range (maximum)
- Resting Energy Expenditure (REE, calories/day)

All of these measurements are included in the data file, as different investigators may have preferences for which forms of the analysis variables they want to use. Target weights and REE are proprietary calculations provided by the algorithms and are included here for completeness, although it is rare that these would be used in analyses. Investigators may also choose to calculate other indices, such as muscle mass. Therefore, the ohms (C4IOHMS) measured during the procedure (the values resulting from the electrical current that passes through the body) are also included in the file to support such calculations.

Note, the manufacturer advises that BIA measurements be completed when the participant is fasting. Research staff collected information about the time and date the participant last ate (reported as number of hours since the participant last ate – C4I7B) as well as what was eaten. This information is included for researchers who may want to use it in analysis, although this is not common. A copy of the tracking form with variable names added is included below with the BIA protocol. Responses to the eligibility questions (Q4-6) are incorporated into the filter variable C4IELIG (see above).

MUSCLE FUNCTION

Muscle power and function is assessed via two tasks (jump, balance) performed on a force plate and assessed via the Leonardo mechanography software. These assessments are only completed at UW.

The Single Two Leg Jump (s2LJ) provides information concerning the state and capability of an individual to perform a motion activity. The main measurement outcome of this is the maximum possible power output (peak power) per body weight. Publications by Runge et.al. (2004) and others show a very good correlation between maximum power output per body weight and age for both sexes in a healthy reference collective.[1]

[1]Runge M, Rittweger J, Russo CR, Schiessl H, Felsenberg D 2004 Is muscle power output a key factor in the age-regulated decline in physical performance? A comparison of muscle cross section, chair-rising test and jumping power. Clin Physiol Funct Imaging, 24:335-340.

1. Jump assessment: participants complete three trials in which they jump as high as possible using both legs and attempt to reach the ceiling. The software generates the measures below.
    a. For each trial

i. Measured Jump Height (meters)
ii. Raw Jump Power (kilowatts)
iii. Relative Jump Power – raw jump power corrected for body weight as measured by the mechanography software (Watts/kg)

b. Summary Measures (for use in analysis)
i. Maximum Height selected from the 3 trials
ii. Raw jump power associated with the selected maximum height
iii. Relative jump power associated with the selected maximum height

2. Balance Assessment: participants complete two sets of trials. Subjects stand with feet about a shoulder's width apart for 30 seconds. The first test is performed with eyes open, two trials are recorded, these trials are then repeated with eyes closed. At M3, the Sharpened Romberg balance assessment was added to data collected. This includes three 10-second tests of Romberg stance variants: standard (feet symmetrically side by side and touching), semi-tandem (toes of one foot next to and touching heel of contralateral foot) and tandem (toes of one foot aligned behind and touching the heel of the contralateral foot). The amount of sway and the relative path are assessed for all 5 conditions to provide the following variables:
a. For each condition (eyes open or closed) and trial
i. Relative path length
ii. Standard ellipse area
b. Summary Measures (for use in analysis)
i. Average path length (2 trials)
ii. Average ellipse area (2 trials)

The jump and balance protocols appear in Section B below. The muscle function variables appear in the data file immediately following the body impedance variables described above. The variable names begin with "C4D".

Some individuals are able to perform the balance tasks, but not the jump tasks due to an injury or some other physical problem. Thus, this section of the data begins with the categorical variable C4DJBAVAIL which indicates whether jump and/or balance are available.

- This variable will be INAPP for all Georgetown and UCLA participants, as well as the UW participants who completed the study visit before jump/balance was added to the protocol.

SECTION B: Protocols

CONTACT INFORMATION

DXA/IQC Related Issues:

1. Diane Krueger
University of Wisconsin-Madison
2870 University Ave. Suite 100
Madison, WI 53705
Phone: 608-265-6410
Fax: 608-265-6409
Email: dckruege@wisc.edu

2. Gretta Borchardt
University of Wisconsin-Madison
2870 University Ave. Suite 100
Madison, WI 53705
Phone: 608-265-6410
Fax: 608-265-6409
Email: gborchardt@wisc.edu

Study Specific Protocol Issues:

1. MIDUS HelpDesk
http://midus.wisc.edu/helpdesk.php

DXA OPERATOR'S SIGN-OFF

This is to insure that all DXA technologists have read and fully understand what will be expected from their site for the DXA procedures portion of the MIDUS study. The material in this manual should be read and understood prior to scanning the first subject. All DXA technologists directly involved with the study must sign and date this form to acknowledge and confirm understanding of DXA requirements for the MIDUS biomarkers supplement study.

Please fax a copy of this form to Diane Krueger at 608-265-6409. The original is to be kept with the study DXA binder at the site.

DXA Technologist (s):

Printed Name and Date (First and Last)	Signature	Initials

INTRODUCTION TO QUALITY ASSURANCE

The purpose of this manual is to standardize DXA scanning procedures among clinical centers participating in the MIDUS study. Bone mineral density is an important endpoint, as such, excellence in obtaining these data are critical. Success will depend on several factors, including qualifications and dedication of the DXA technologists, clear understanding of the study requirements and good communication between the clinical sites, study investigators and UW Osteoporosis Research DXA QA Center.

Site Responsibilities

- Monitor DXA scanner performance throughout the study duration.
  1. Daily QA
  2. Phantom QA
  3. Notify UW DXA QA Center of all hardware issues or replacements
  4. Notify UW DXA QA Center of all software problems or upgrades
- Ensure that DXA measurements are skillfully and consistently acquired for each subject, following the procedures in the manufacturer's operator's manual and this manual.
  1. Demographic entry
  2. Scan modes
  3. Positioning and acquisition
  4. Data back-up and archival
- Data transmission to the UW DXA Center
  1. Subject DXA scans
  2. Instrument Quality Control data

UW DXA QA Center

- Monitor the performance of all densitometers used for DXA acquisition and provide a summary of scanner performance at the study conclusion
  1. Collect all QA data from study sites
  2. Analyze, maintain and validate QA data
  3. Assure that sites submit QA and study data in a timely manner
- Assure consistent acquisition and analysis of subject scans among individual densitometry study sites
  1. Analyze and retain all images for every subject
  2. Retain DXA data in an orderly fashion for the duration of the study
- Assure that study sites have proper supplies needed for DXA data transmission
  1. Study specific DXA forms

CROSS CALIBRATION PHANTOM MEASUREMENT

The purpose of cross calibration phantom assessment is to ensure that DXA measurements at different clinical study sites may be compared. Your site cannot start scanning subjects until cross calibration phantoms have bene measured. Your site will be contacted as to when you may start scanning subjects.

You will receive a BoneFide® encapsulated spine phantom and Bioclinica Whole Body phantom before the study begins. You will be contacted to determine a time when these phantoms will arrive at your site; please scan cross calibration phantoms in a timely manner. Each site will scan the phantoms ten times on the same day without repositioning. A courier service will be used to deliver and forward the phantom to the next study site after cross-calibration phantom scans are complete. You will need to send the cross calibration form and scan files to the UW DXA QA Center via the FTP site.

INSTRUCTIONS FOR CROSS CALIBRATION PHANTOM MEASUREMENT

Patient Biography

The first subjects (in the new GE database) for this study will be the cross calibration phantom. Please create the patient BoneFide® and Bioclinica phantoms as follows:

MANDATORY INFORMATION
LAST NAME: Cross-Calibration Phantom
FIRST NAME: Spine or Whole Body as appropriate
MIDDLE INITIAL: Leave blank
ETHNICITY: White
SEX: F
BIRTHDATE: 11/11/1951
PATIENT ID: Leave blank
IDENTIFIER 2: Site location (e.g.: UW, UCLA, Georgetown)
REFERRING PHYSICIAN: Leave blank
MENOPAUSE AGE: Leave blank
WEIGHT: 130 lbs or 60 kg
HEIGHT: 65 inches or 164 cm
PATIENT COMMENT: Cross Calibration / Technologist initials

Scan Acquisition

Please set the parameters to the default mode and use array, if applicable.

Spine: Position the phantom on the scanner pad after the machine's scan arm has moved to the approximate start position. Position the phantom so that the laser light is on the start position indicated on the spine phantom, or above the "head" of the whole body phantom. **DO NOT move the laser light, move the phantom to the laser light.** Make sure that the phantom is parallel to the scanner's long axis with the starting mark pointing toward the foot end of the table. The phantom should be approximately in the center of the scanner table.

Begin scanning the phantom. The phantom image should be straight and centered in the scan field, if not, reposition the phantom and restart the scan.

Please allow the scanner to finish on its own, do not stop it prematurely.

Scan the phantom nine more times. The starting point for subsequent scans will be correct as long as the operator does not move the scanner arm or the phantom between scans.

Total Body: Position the phantom on the scanner pad 10cm from the starting line. Make sure that the phantom is parallel to the scanner's long axis; the phantom should be approximately in the center of the scanner table.

Begin scanning the phantom. The phantom image should be straight and centered in the scan field, if not, reposition the phantom and restart the scan.

Stop the scanner when the scan has reached 10 cm below the end of the phantom.

Scan the phantom nine more times.

Scan Analysis

Please use "Auto Analysis" to place ROIs on the first phantom (spine or total body), but do not accept the default analysis. **Additionally, DO NOT alter bone edges or baselines.** Analyze the spine L1-L4 region by using the scan image and histogram to place intervertebral markers between each vertebrae. On the total body phantom, place the ROIs to mimic human regions, i.e. chin line, spine edges and joint cuts. Use the copy/compare function to analyze the remaining nine scans, using the first scan as the reference. Detailed information on acquisition and analysis will accompany the phantoms. Transfer all scans files to the QA Center via FTP.

DXA SCANNER PERFORMANCE

BASELINE PHANTOM RANGE

Phantoms should be scanned prior to starting the study and at least three times per week throughout the study using your site's phantom, and on all days that study participants are scheduled. When analyzing phantom scans please use the copy/compare function.

Before scanning any study subjects, please scan your phantom a total of 10 times without repositioning to establish a baseline. Analyze these as described in the Cross-Calibration section and submit scan files via the FTP site. You will receive a document from the QA center notating the range your phantoms should fall for the study duration. If two consecutive values fall outside this range over the course of the trial, it is recommended that you contact your DXA service provider.

DAILY QA

Quality assurance should be performed at least three times per week and on all days that study subjects are scheduled to ensure stable scanner performance. QA must be obtained before subjects are scanned.

If the QA does not pass on the first try, please repeat. Make sure that the QA block or phantom is positioned correctly. If QA fails twice, please refer to your manufacturer's manual for instructions. **If QA fails two consecutive times, DO NOT** scan study participants; if QA fails, reschedule or cancel the appointment.

HARDWARE PROBLEMS OR REPLACEMENTS

Please notify the UW DXA center by faxing the DXA Service form if there are any scanner hardware problems during the study and include a copy of the service reports. The UW DXA center must be notified when hardware changes are required. If possible, please scan your QA phantom 10 times before hardware changes are made and 10 times after replacement or service has been completed. This is to determine if changes in machine calibration occur.

SOFTWARE PROBLEMS OR UPGRADES

Please notify the DXA QA Center faxing the DXA Service form if there are any scanner software problems during the study. Ideally, no software upgrades should occur during the study, however, if software changes are scheduled to occur, please notify the DXA QA Center prior to making this change. Additionally, please scan the QA phantom 10 times before and after such changes are made. This is to determine if the software upgrade resulted in machine calibration changes.

ACQUIRING SUBJECT BONE MINERAL DENSITY SCANS

SUBJECTS

All premenopausal women will have a urine pregnancy test performed prior to DXA scan acquisition. Project staff will administer a screening questionnaire before the participant arrives for bone density scans. The technologist should review the screening questions with subjects prior to beginning the scan to confirm accuracy and determine which scans should be performed. Ensure subjects have had time to clear any radioisotopes administered for radiologic or nuclear medicine imaging.

The following scans should be obtained in the order listed to ensure adequate rest time (10 minutes) prior to bioelectric impedance (UW only) and ankle brachial index testing.

Vertebral Fracture Assessment (VFA) (if system has rotating C-arm, obtain the forearm first and VFA lumbar spine)

Forearm
Lumbar Spine
Dual Proximal Femur
Total Body

DEMOGRAPHIC ENTRY

Subject ID numbers will be assigned by your local site study coordinator. Please enter the subject's demographics in the following manner using data provided by the study coordinator (Bone Density Information Sheet appended to the end of this manual) as follows:

Last Name: Subject Initials (including middle, use dash if none)
First Name: MIDUS
Middle Initial: Leave Blank
Ethnicity:
Sex:
DOB:
Patient ID: Enter 5 digit Subject ID
Identifier 2: Site location (UW, UCLA, Georgetown)
Referring Physician: (Investigator's Name)
Menopause Age: (Not Applicable to MIDUS, Leave blank)
Weight (kg):
Height (cm):
Patient Comment: (MIDUS Study, Technologist Initials)

DXA SCAN MODES

Subjects should be scanned in the same modes routinely used at your site, unless a different mode is indicated due to subject size.

POSITIONING AND SCAN ACQUISITION

General Guidelines for Scan Acquisition

- Describe scanning procedures
- Assure that recent GI contrast or nuclear medicine scans have not been done, do not perform scans if contraindicated.
- Ensure the volunteer removes any metal around the scanning area (e.g., zippers, belts, coins/keys in pockets, etc.).
- The volunteer should be positioned using the manufacturers positioning devices (foam block, foot positioner and sponges).
- Ask the subject to remain still for the scan duration.

<u>FOREARM</u>

Scan the non-dominant forearm, unless there is an internal artifact or prior fracture. If both forearms have been fractured, select the side with fewest abnormalities. Scans may be obtained in a supine or seated position.

GE

Place the subject supine on the table, off-center, so that the arm you are measuring is with in the global scan field. Ensure the forearm is free of external items (clothing, jewelry, hospital ID bands, etc.), place the forearm scan positioner under the arm and hand, you MUST use the forearm positioner. Ensure the arm is straight on the positioner and centered between the strap slots, point the start laser just distal to the radial tip and in the center of the wrist. The arm should be straight, centered in the scan field, show one row carpal bones and the distal tips of the ulna and radius. Reposition and restart the scans as needed to obtain this image. Inspect the soft tissue bone typing to ensure is does not include "air" outside the arm. If it does, repeat the scan with the positioner slots outside the scan field. Analyze for local interpretation per your SOP, but do not save.

Hologic (seated)

Use of the forearm positioner is optional. A chair should be positioned at the center of the table, but not touching. Have the participant place their arm on the table within the global scan field. Ensure the forearm is free of external items (clothing, jewelry, hospital ID bands, etc.). Measure and record the forearm length in cm, from the tip of the ulna to the elbow. Position the subject with their forearm resting on the table, with the hand in a soft fist.

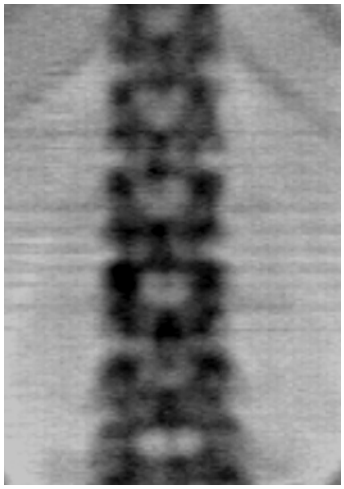
Left forearm: Point the laser at the mid-forearm, parallel to the arm, and in line with the ring finger. Verify that the first row of carpal bones are within 15 cm of the starting point. **Right forearm**: Point the laser at the first row of carpal bones, parallel to the arm, and in line with the ring finger. Warn the subject that the scanner arm will move toward them, and may touch them, during the scan. The arm should be straight, centered in the scan field, show one row carpal bones and the distal tips of the ulna and radius. Reposition and restart the scans as needed to obtain this image. Analyze for local interpretation per your SOP, but do not save.

Hologic (supine)

Measure and record the forearm length in cm, from the tip of the ulna to the elbow. Have the participant supine on the table ensuring their arm is within the global scan field. Ensure the forearm is free of external items (clothing, jewelry, hospital ID bands, etc.). Position the subject offset to table edge with contralateral forearm across waist, have their forearm resting on the table, with the hand in a soft fist.

Left forearm: Position as above with subject's head at the foot of the table. Point the laser at the mid-forearm, parallel to the arm, and in line with the ring finger. Verify that the first row of carpal bones are within 15 cm of the starting point. **Right forearm**: Point the laser at the first row of carpal bones, parallel to the arm, and in line with the ring finger. The arm should be straight, centered in the scan field, show one row carpal bones and the distal tips of the ulna

and radius. Reposition and restart the scans as needed to obtain this image. Analyze for local interpretation per your SOP, but do not save.



SPINE

Position subject supine in the middle of the table, place a sponge block under their legs to obtain 90º of flexion at the knees and hips. Their hands should rest on the table, palms down, separated from torso. Point the laser 3-5 cm below the navel to mark the start point. Include at least half of L5 and T12 and assure that the lowest ribs are visible. All subjects should be positioned in the center of the table as straight as possible. As needed, reposition the volunteer or start point to ensure the spine is straight and centered in scan field with L5-T12 imaged, restart scanner as necessary. Analyze for local interpretation per your SOP, but do not save.

VFA

Rotating C-arm Scanner procedure

Subject will already be supine in the middle of the table from the lumbar spine acquisition. The sponge block under their legs should remain to obtain 90 degrees of flexion at the knees and hips. Place the U-shaped sponge under their head and have them rest their arms on the edges. Place the laser light about 5 cm below the navel. Ask the participant to take a small breath and hold it for the duration of the scan. Acquire at least all of L5 – T4, imaging of additional vertebral bodies is acceptable. DO NOT analyze or perform morphometry.

Fixed Scanner arm procedure

Place positioning devices on the scanner table (backrest – GE, U-shaped sponge – Hologic). Position subject in the left lateral decubitus position, with back up against backrest (GE) or head in positioning sponge (Hologic). If needed to align the spine parallel to the table, place curved sponge between hips and rib cage. Square shoulders by resting right elbow on the dual femur positioner (GE) or positioning sponge (Hologic). Point the laser about 4 cm below the iliac crest and in-line with the spine. For Hologic only, ask the subject to take small breath and hold for the duration of the scan. On both instruments, the scan should start just below L5 and include at least T4, it is acceptable to include additional vertebrae. DO NOT analyze or perform morphometry.

FEMUR

Both femurs will be measured. Do not scan hips that have metal artifact (pins, screws, plates, prosthetics, etc.) in the scan region. Position subject supine in the center of the table with shoes removed. Place the hip positioner between the participant's feet, aligning the center with the table's midline. The subject's heel should sit in the middle of the positioner. Lift the leg to be examined placing hands just above and below the knee. Rotate above the knee approximately 25-30º then place the leg on the table with foot resting against the femur positioner. Strap the foot in the positioner, then adjust the leg abduction so that femur shaft is parallel to the table, ensuring to keep the hip rotation. Note: For participants who are able to tolerate having both hips rotated at the same time, it is acceptable to position the legs one at a time. Confirm that the participant is properly positioned and place the laser light 1 cm lateral of center on the thigh and below the iliac crest about 20 cm. NOTE: In very obese participants, the fat pad of the belly can overlie the femur

neck or trochanter, artificially altering the BMD. This is a major source of error, which will cause the analysis of the scan to be inaccurate. When presented with an obese participant, determine if the fat pannus will cause a problem with the scan. If so, ask the participant to retract the tissue out of the scan field with their hands by pulling it up and away from the proximal femur area, ensuring their hands are out of the scan field. **Hologic**: Start the scan and stop just past the most lateral aspect of the greater trochanter and use the software's positioning tool to ensure correct placement and inclusion of appropriate anatomy. **GE**: To ensure adequate soft tissue sampling, obtain 2 swipes of femur shaft, the ischium should appear on the third swipe, there should also be 3 swipes above the femur head before ending the scan. **Both**: Once the left hip is complete the program will reposition for the right hip, repeat the positioning and scan instructions above. Analyze for local interpretation per your SOP, but do not save.

TOTAL BODY

On Hologic machines, choose the Whole Body or HP Whole Body mode (for obese participants) in the Scan Type list.

Position subject supine, centered in the scan field markings on your table pad, place arms at the sides with palms down and separated from the thighs. Make sure the whole body is within the scan field, ask the subject to keep their fingers tight together to avoid intrusion into other regions. Ensure no pillows, positioners or miscellaneous items are on the scanner table. Subjects should be parallel to the table with feet together, strap the ankles to minimize movement. For subjects that are too tall for the scan field eliminate some of the head and include all the feet. For participants that are too wide for the scan field perform a hemi-scan: **Hologic**: have the subject extend their left arm 90º to their torso, and ensure the rest of their body is in the scan field as described above. **GE**: have the subject move left, as needed, until the entire right side is included in the scan field. Instruct the participant not to move and breathe normally. Analyze for local interpretation per SOP, but do not save.

DATA BACK UP AND ARCHIVING

Backup and archive all study and phantom DXA scans daily per your local standard operating procedures. GE users should create a separate database for this study.

SCAN ANALYSIS

Please DO NOT send analyzed scans. Analyze and print results for local interpretation, but do not send these files to the DXA QA Center. VFA scans will be read centrally and no morphometric analysis is required for local assessment. All subject scans should be sent to the UW DXA QA Center unanalyzed.

SUBMITTING DATA TO UW

SUBJECT DXA SCANS

The raw un-analyzed Subject DXA scans should be copied from the scanner computer to a flash drive for transport back to the project office. Project staff will then upload the files to the MIDUS Biomarker (Project 4) FTP site. All required DXA uploads to the FTP site, including QA, should be current by the 5th of each month to allow for regular data evaluation. Before uploading any file, complete all associated forms and rename files as noted below:

- Please ensure that all subject information is accurate
- Keep the name assigned to subject scan files by the Hologic software and add an extension containing subject ID;
    - i.e. PA05307A-UCLA-14567 (Hologic name-Site-MIDUS subID)
- Update your sites DXA Logsheet to included information from the scans to upload (see attached Subject DXA Logsheet.xlsx; details about completing some fields is revealed by clicking in the spreadsheet and hovering over the column headers)
- Label file with your site, i.e. "Logsheet UCLA" and have a current version uploaded with each set of subject scan files

After completing the above project staff will upload all scan files and the Subject DXA Logsheet to the Bone folder for your site (i.e. \Bone\UCLA\Subjects).

INSTRUMENT QUALITY CONTROL (IQC) DATA

IQC data should be sent by the 5th of the following month as noted above.

Simply add your site name to each phantom scan file, i.e.; PA05307A-UCLA. Complete and label the DXA IQC Transmittal Form (IQC DTF) with your site and QA month/year (i.e. IQC DTF UCLA 0417). This form is provided on the following page with notations as how to complete. It can be completed and signed electronically using Adobe Acrobat Reader or Professional, do not use a different text-editing program or the information you enter may not be saved in the file. You can formally sign the bottom or simply type your name in the provided field. Upload this file, along with associated scan files, monthly to the QA folder for your site (i.e. \Bone\UCLA\QA).

DXA Quality Assurance Data Transfer Form

Investigator: *Enter MIDUS Investigator name* **Site:** *Enter site name*

MONTHLY QA **Month/Year:** *of phantom acquisitions*

Comments:

Enter information regarding phantom acquisition, i.e. missed days, values outside acceptable range or scan errors. If no issues, state there are no concerns.

DXA Service: ☐ **YES** ☐ **NO** **If YES, please see below.**

Please describe hardware or software changes, type of service, issue, or state preventative maintenance including dates. Provide a copy of the service report where applicable.

Enter specifics regarding instrument service, for example, routine preventive maintenance or description of problem prior to requesting service. Scan and upload affiliated service reports with this form.

Staff Changes: ☐ **YES** ☐ **NO** **If YES, please describe below.**

Name: *Enter name of new staff* Phone: *list affiliated phone*

Email: *list affiliated e-mail* Fax: *list affiliated fax*

Remove or replace the following staff: *specify if staff should be removed from project*

Please note if there has also been a change in point of contact for reports and queries.

Specify if addition or removal of staff has resulted in a change of primary contact.

Signature: _____ Date: ____/____/____
(Person completing the form)

Print Name: _____
(Person completing the form)

MIDUS 3– Biomarker Project
Bone Densitometry Information Sheet

DATE _____ ID #_____

SITE ID _____

NAME _____
first middle last

INITIALS _____

DOB (verify with R) _____/_____/_____

ETHNICITY_____ SEX_____

Ht _____(cm) Max Ht _____ (inches)

Wt _____(kg)

COMMENTS:

TECHNOLOGIST INITIALS _____

INVESTIGATOR _____

Form is returned to Project Office

MIDUS Contact: (insert staff name & contact number)

CRU – (include if appropriate)

NOTIFY MIDUS STAFF IF ANY PART OF THE BONE DENSITY VISIT ARE NOT COMPLETED.

BIOELECTRICAL IMPEDENCE: SPECTROSCOPY PROTOCOL (UW)

Bioelectrical Impedance Spectroscopy (BIS) Procedure

Preparation: Participants should:

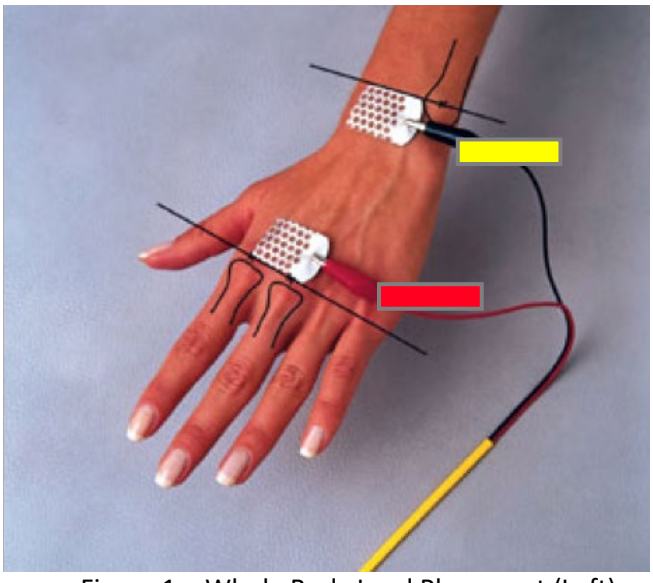
- be supine for at least 10 minutes, consequently, this will be performed following the DXA scans (performed in the order of VFA, FA, LS, PF & TB)
- void bladder prior to performing procedure
- not be wearing or touching any metal
- report their last meal- when and what they last ate
- remove socks prior to DXA scans, right knee will need to be exposed for BIS
- not have the BIS test if they have a pacemaker
- be positioned so arms and legs are separated from the body- if necessary, use foam wedges

Procedure:

- Unplug the BIS equipment prior to performing procedure and connecting the leads
- Run the test cell on all days the equipment is used
- Turn power on
- Hit "Measure" on the screen
- The "Measurement Setup" screen will appear.
    - Touch "File Name" to bring up the edit box with a keypad. Label this with "Three Subject Initials" [space] "Subject ID #" [space] and which test is being performed ("TB" for total body, "LG" for leg and "LL" for lower leg measurement). If no filename is listed- the measurement data will NOT be saved.
    - Touch "Patient Details Edit." This is where the gender, height, weight, and age are updated. This is done by touching the arrow buttons located next to the detail (gender, height, weight, etc.) This can also be done manually by touching the box itself, and a keypad will appear.
- Clean the sites where electrodes will be placed with alcohol
- Apply the electrodes (Figs 1 - 2)
    - Left hand - Feel the protruding bones (distal ulnar styloid and radial tip) of the wrist, draw a line spanning straight across the wrist from the top of the protruding bones. Place the first electrode so that the edge of the electrode rests on, and is placed distal to, that line. Place the second electrode edge proximal to the knuckle aligned with the index and middle fingers, no less than 5 cm from the first lead.
    - Left foot - Feel the protruding ankle bones (malleolus bones) and draw a line spanning from level with the protruding bones, across the ankle. Place the first electrode so that the edge of the electrode rests on, and is placed distal to, that line. Place the second electrode edge proximal to the base of the toes aligned with the second and third toes, no less than 5 cm from the first lead.
    - Right foot - Place one electrode so that the bottom edge is edge proximal to the base of the toes aligned with the second and third toes. There is no second electrode on the right foot.
    - Left knee – One electrode is placed on left side of the body on the articular cleft between the femoral and tibial condyles. The placement can be found when the participants bent the left knee fully. A wrinkle is made on the lateral side of knee when the participants bent the left knee fully. Place one electrode on the wrinkle.
- Attach the leads - Attach an alligator clip to each of the probe tips of the four leads. (Fig 1)

- **Total body measurement (Figs 1, 3):**
    - Yellow (Sense lead) - Attach to the electrode placed at the wrist of the left hand
    - Red (Current source lead) - Attach to the electrode placed distal to the yellow lead on left hand
    - Blue (Sense lead) - Attach to the electrode placed at the left ankle joint
    - Black (Current lead) - Attach to the electrode placed distal to the blue lead in the on the left foot.

- Once all leads are connected, touch the “Measure” button on the opening screen OR press the large green button on the front of the device. The “Begin measurement” screen will show; summarizing the subject information you have entered. Press “Start” or the large green button. The device will take the measurement, and results will immediately appear.
- The data is saved, just hit back to get to the measure screen, then push “Start” or the green button again to perform the same measurement a second time
- Next, to switch measurement areas, go back to the patient information screen and edit the filename to say “subject initials,” “subject ID number,” “LG”
- **Total leg measurement (Fig 3)**
    - Do not change the lead placement on the left ankle and foot.
    - Move the yellow (sense lead) from the left wrist and attach it to the electrode on the right foot, leave the red lead in place on the left hand.
- Perform 2 measurements with this lead positioning
- Next, to switch measurement areas, go back to the patient information screen and edit the filename to say “subject initials,” “subject ID number,” “LL”
- **Lower leg measurement (Fig 2)**
    - Do not change the lead placement on the left ankle, foot or hand.
    - Move the yellow (sense lead) from the right foot and attach it to the electrode on the left knee.
- Perform 2 measurements with this lead positioning
- Hit “back” to get back to the main screen.
- Remove the leads from the subject
- Remove the electrodes from the subject, wipe the area with alcohol to remove residual glue



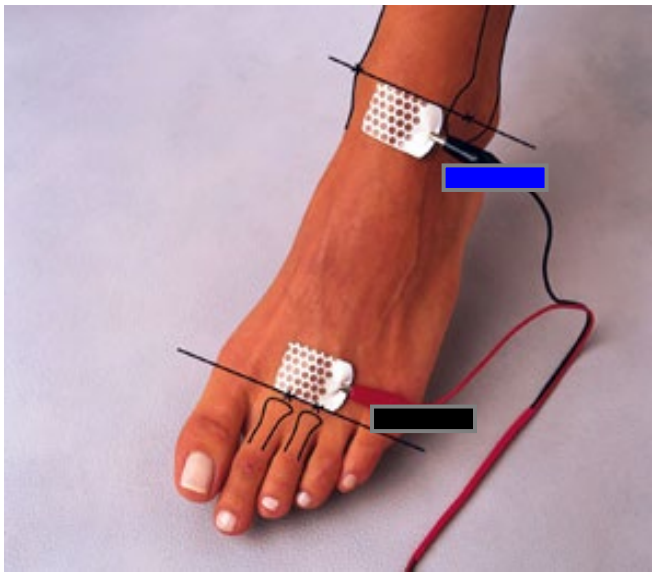


Figure 1 - Whole Body Lead Placement (Left)

Figure 2 – Lower Leg Lead Placement (Right)

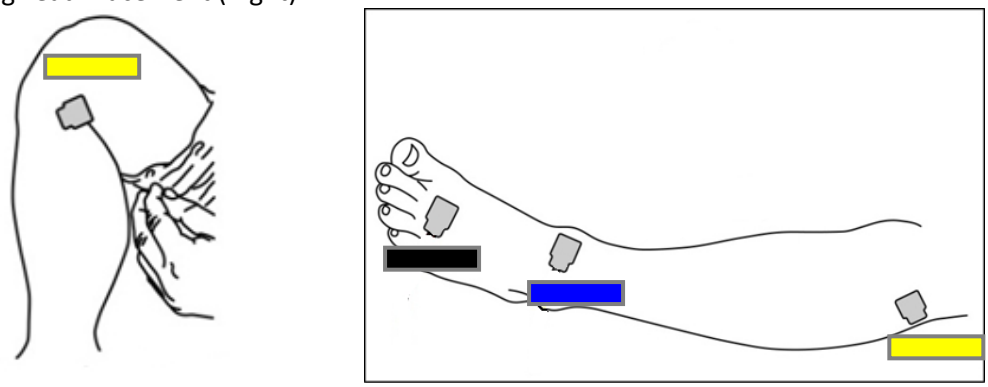
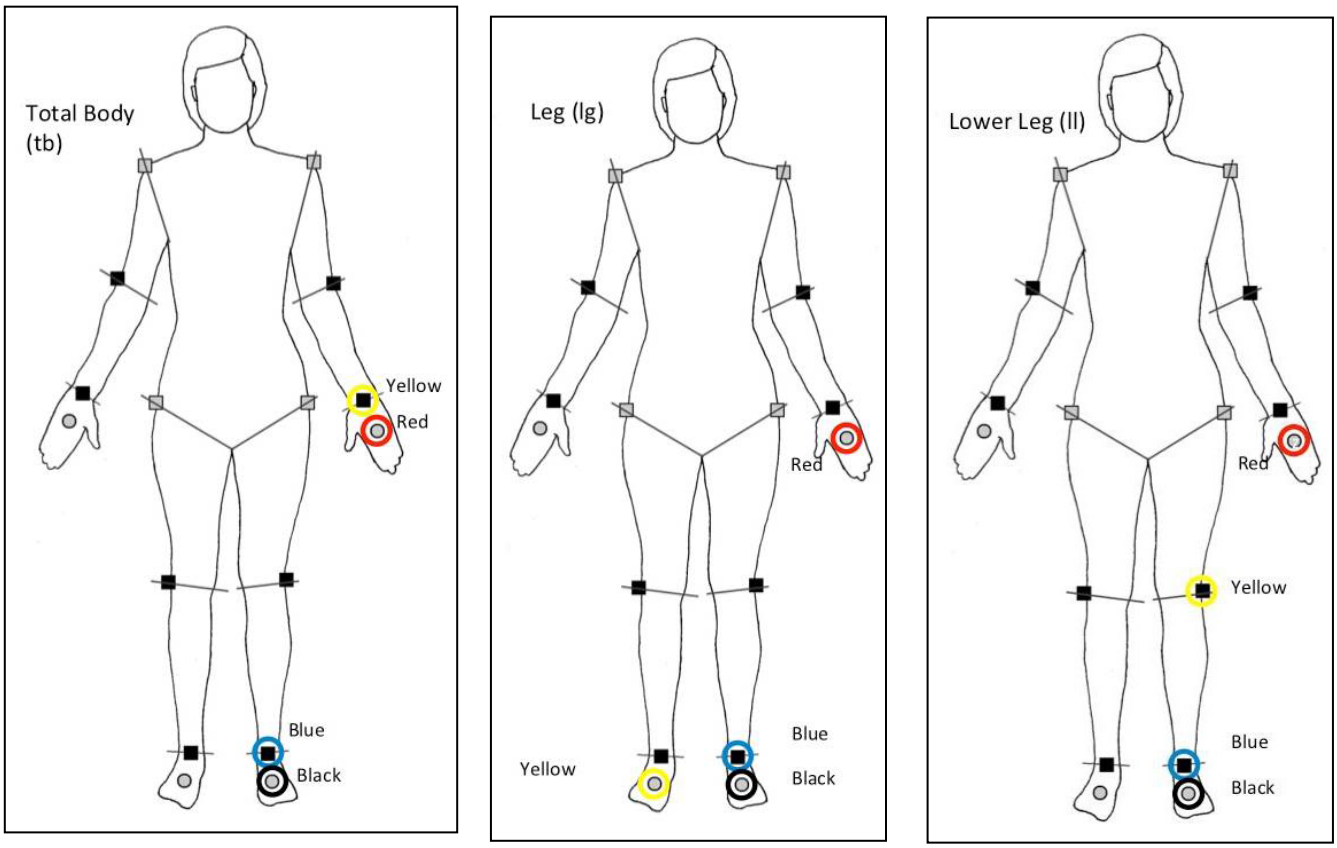


Figure 3 Lead Placement Overview



BODY IMPEDANCE PROTOCOL: (UCLA & GEORGETOWN)

The goal of this procedure is to assess the body composition of the MIDUS 3 participants, using the Body Comp Scale manufactured by Valhalla Scientific.

VISIT PREPARATION

In preparation for the visit, ensure that the following supplies are available:

- Body Comp Scale
- Printer
- MIDUS Body Impedance (BI) Procedure Tracking form
- Lysol disinfectant spray
- Dry wipes

Disinfect the scale prior to each participant's use. Use the Lysol disinfectant spray and wipe down the machine with a dry wipe. Also, ensure that the scale is on a firm, level surface. Ensure that the scale and printer are connected at that the printer has paper.

Note: The most accurate measurement will be obtained if the participant has not eaten or drunk, or has consumed very little, in the 6 hours preceding the assessment. If this is not feasible encourage the participant to refrain from eating or drinking in the hour or two immediately preceding the assessment. To assist with data analysis, the BI form includes a place to record information about when and what the participant last ate/drank.

MEASURING BI

1. Confirm that printer is connected and functioning properly (see instructions in manual from Valhalla Scientific)

2. Record the following information on the top of the form:
    a. BI Calibration Date – obtain this information from the designated location (see Calibration section below)
    b. Participant Height – obtain this information from the Vital Signs section of the Physical Exam form (Question 1a).
        i. The height on this form should be a whole number, round as needed according to the standing rule.
            1. If 0.5 or greater round up, if less than 0.5 round down.
    c. Day Collected – check appropriate box, either Day 1 or Day 2
    d. Visit Date – Visit Date is the Day 1 date, regardless of which day the BI is performed. Enter the Day 1 date at this question.
    e. Time – enter the time the BI was performed and circle AM/PM.

3. Assess participant eligibility for BI by asking questions Q4-6 on the BI tracking form.
    a. If the participant responded 'NO" to all of these questions, proceed with measurement.
    b. If the participant responded Yes to
        i. Q4 (pacemaker or medical device) do not complete assessment because the electrical current could interfere with the device's normal function. Go To Q9.
        ii. Q5 & 5a (prosthetic limb or joint):
            1. If YES to prosthetic ***limb*** do not complete the assessment because the electrical current cannot pass through the prosthesis
            2. If YES to prosthetic ***joint***, ask Q5a (is joint metal?).
                a. If prosthetic joint is made of metal, do not complete the assessment.
                b. If the prosthetic joint is made of newer, non-metal material, complete the assessment.
            3. If Respondent reports metal plates/pins in body in response to this question, then do NOT complete the assessment.

4. **Note**: If the only metal is in the neck, it is ok to continue because the current goes through the shortest path from hands to legs and the neck is not on that path.

iii. Q6 (pregnancy) do not complete the assessment because the measurement will not represent the woman's regular body composition. Go To Q9.

4. Assess when the participant last ate or drank (Q7-8).

5. Ask the participant to remove socks and shoes. The participant must have bare feet and hands for this procedure. Also make sure participant is not carrying or wearing a significant amount of metal (i.e. remove keys, change from pockets, if wearing heavy belt buckle remove).

6. Instruct the participant to stand in the middle of the balance scale platform with head erect and eyes looking straight ahead.

7. Once the participant is correctly positioned, enter information about the participant in the device:

   - Height display will flash. Select Metric measurements by pressing the LBS/KGS button on right hand side of display face
   - Enter height (recorded on the Physical Exam form) in centimeters, ex. 179 cm. Press enter.
   - Enter Gender: Press one of the gender buttons (MALE or FEMALE)
   - Enter Age.

8. When GRIP appears on display, ask participant to grip the metal handles on each side of the display module. Thumbs should rest comfortably on the top metal handle and fingers should be in firm contact with the lower metal handle.

9. Participant must remain still with hands in contact with handles and feet in contact with metal surface of the base until Body Weight and Body Fat % results are displayed **AND** results are sent to the printer.

10. Ask participant to get off the scale.

11. Using the device touchpad, select PLAIN and select ENTER in order to print results.

12. Write the participant's ID # on the form in the space for the name, then staple the form and the printout together so the printout is the second page.

13. Field Editing: the BI tracking form should be field edited according to the general guidelines (See MIDUS 3 Field Editing Guidelines, in the MOP Appendix D).

    Specific guidelines:

    - Q1-3 Should always be completed, even if the BI is not done due to ineligible or technical problems
      - ***If BI is not done due to ineligible***, follow the skip pattern, all the items that are skipped should be blank.
      - ***If the BI is not completed due to technical problems*** (i.e. printer not working, equipment not available), ***the entire form should be completed.***
    - Be sure the Visit Date is the date of Day 1.
    - The Time entered at Q3 should be recorded on a 12 hour clock
      - If it is recorded as a 24 hour clock convert to 12 and check am or pm as appropriate.
    - Height should be recorded as a whole number, if a decimal was record round according to the standing rule (see above).

- Q9 (Was BI completed) –
    - If YES, go to Q10 (Missing Data)
        - IF the form containing the data cannot be printed then indicate YES to Missing data at Q10 and record the reason why in the in the Explain line.
        - If the form was printed with all the usual information, then circle NO at Q10.
    - If NO, (BI not completed) explain why and then continue to Q10 and circle INAPP.
        - If not completed due to ineligible then the response to at least one of the Eligibility questions (Q4-6) should be YES.

14. These materials will be sent to UW monthly for data entry and processing. At the end of each month complete the following steps:
    a. Compile the tracking forms with attached BI printouts for the month.
    b. Make a copy of each set of materials for your local files (UCLA and Georgetown only)
    c. Add appropriate details to the Materials Packing Slip regarding materials included in the shipment
    d. Combine with other materials to be shipped to UW

CALIBRATING THE BCS SCALE

Calibrate machine once a month at the end of the month. Each site should determine who will do this and designate a location for logging this information. The MIDUS staff person completing the BI assessment will record this information on the form.

MEDICAL DEVICES AND METAL IN THE BODY

Per guidance from UCLA MDs during the Refresher data collection individuals with pacemakers or implanted medical devices are not eligible for the Body Impedance assessment as the electric current may interfere with the functioning of those devices.

In addition, individuals who have prosthetic joints (e.g., knee, hip) are not eligible for the Body Impedance assessment if the joint is made of metal. If the joint is newer and made of non-metal material the assessment can be completed.

Documentation of these decisions is in Appendix A below.

APPENDIX A: DOCUMENTATION OF DECISIONS BY UCLA MD's

Per Dr. Karlamangla's email on 1/23/2015 regarding pacemaker
It is a strict contraindication for BI measurement
Per Dr. Karlamangla's email on 1/23/2015 regarding implanted defibrillator
It is a strict contraindication for BI measurement
Per Dr. Karlamangla's email on 1/23/2015 regarding steel knees without metal

a. fine to move forward with BI

Per Dr. Karlamangla's email on 1/23/2015 regarding steel knees with metal
Exclude from the BI
Per Dr. Srikanthan's email to Dr. Karlamangla on 1/23/2015 regarding any implanted medical device and any joint replacements:
Exclude from the BI
Per Dr. Karlamangla's email on 4/27/2015 regarding Titanium in body.
Metal in limbs can falsely reduce BI and overestimate muscle mass. But metal in the neck should not be a concern since the neck is not on the shortest pathway from hands to legs. Moreover, titanium (although a metal) is a very poor conductor of electricity. So, it is fine to measure BI in a person with titanium in the neck.
Per Dr. Karlamangla's email on 6/22/17 regarding metal plates/pins in body.
The presence of a significant amount of metal in or on the person reduces impedance and overestimates muscle mass.

Metal Type	Perform BI	Reasoning	Date	Item Reference
Pacemaker	No	Contraindication	1/23/2015	#1
Implanted Defibrillator	No	Contraindication	1/23/2015	#2
Steel Knees (if is a modern prostheses which doesn't have metal)	Yes	None	1/23/2015	#3
Steel Knees (if made of metal such as titanium)	No	BI will be erroneous	1/23/2015	#4
Any Implanted medical device	NO	Per Dr. Preethi Srikanthan	1/23/2015	#5
Any joint replacements	NO	Per Dr. Preethi Srikanthan	1/23/2015	#5
Titanium in Neck	Yes	Titanium is a very poor conductor of electricity.	4/27/2015	#6
Metal Plates anywhere but neck/head	No	Per Dr. Karlamangla	6/22/17	#7

JUMP MECHANOGRAPHY PROTOCOL

QUALITY ASSURANCE

The jump platform should be calibrated weekly using certified calibration weights. Create a test subject in your database. With gloved hands, stack three 20 kg weights on one corner of the platform and record the measured weight. Repeat this process for each of the other three corners. Additionally, place two weights side by side in the middle of the platform and place the third weight on top to get a central measurement. Each measurement should be ± 0.5 kg. If any of the measurements are outside of these limits, consult manufacturer guidelines for recalibration.

SUBJECTS

Participants should feel comfortable performing jump and balance tests. These are safe activities that can be performed by anyone that can stand independently. However, if a subject has a condition impacting the lower limbs, such as amputation, recent surgery or injury, and is consequently not comfortable performing the test, omit the test and document the circumstances. If the participant would like to try, or perform fewer trials, this is acceptable and the test can be performed at the discretion of the study staff.

Eligible respondents will perform five balance tests. The first two are performed one with eyes open and one with eyes closed, two trials for each condition. The next three are performed once each, eyes open, with the feet placed in three different positions. Respondents also perform one countermovement jump test consisting of three trials.

SUBJECT DEMOGRAPHIC ENTRY

Subject ID numbers will be assigned by your local site study coordinator. Please fill in the subjects demographic as follows:

Patient ID: (Subject ID – obtain from study coordinator)

First Name: MIDUS

Last Name: Subject Initials

Date of Birth: Complete as appropriate

Gender: Complete as appropriate

Leave rest of fields blank

SUBJECT POSITIONING AND TEST ADMINISTRATION

General Guideline for Exam

- Briefly explain the jump and balance tests
- Reassure that you will evaluate the subject during the exams for safety and the gait belt and spotters will reduce the risk of injury
- Ask the subject if they are comfortable performing the tests
- Fasten a gait belt to subjects that are at risk for falling, in your opinion
- Perform the balance tests before the jump test

- Read the instructions to participants before performing each test and make sure they understand what they are to do.

Balance Tests

Perform these tests with subjects standing on the platform, facing forward with one foot on each platform. Collect two trials for the first two tests, repeat any trial that has acquisition errors. The three SPPB balance test are only collected once each. Read the following instructions for each condition; always perform the eyes open test first:

Balance Eyes Open (x2)

1) We are going evaluate your balance while you stand with your eyes open. We will do this 2 times.
2) Stand as still as possible with one foot on each half of the platform and arms down at your sides.
3) This test will last for 30 seconds. The single beep tells you the test has started.
4) After 30 seconds you will hear two beeps; this tells you the test is over.
5) We will stand nearby to help in case you become unsteady.

Balance Eyes Closed (x2)

1) We are going evaluate your balance while stand with your eyes closed. We will do this 2 times.
2) Repeat the positioning used for the previous test.
3) This test will last for 30 seconds. You must close your eyes before the single beep tells you the test has started.
4) Keep your eyes closed for the entire test.
5) After 30 seconds you will hear two beeps; this tells you the test is over.
6) We will stand nearby to help in case you become unsteady.

Short Physical Performance Battery (SPPB) Balance Tests

I'm going to show you a series of positions and I'd like you to try to do them. In each position, keep one foot on each half of the platform.

A. *Romberg*

1. I want you to try to stand with your feet together for about 10 seconds. Try to hold this position until you hear two beeps.
2. Tell me when you would like the test to start.

B. *Semi-Tandem*

1. Now I want you to try to stand with the side of the heel of one foot touching the big toe of the other foot for about 10 seconds. You may put either foot in front, whichever is more comfortable for you. Try to hold this position until you hear two beeps.
2. Tell me when you would like the test to start.

C. *Tandem Stand*

1. Now I want you to try to stand with the heel of one foot in front of and touching the toes of the other foot for about 10 seconds. You may put either foot in front, whichever is more comfortable for you. Try to hold this position until you hear two beeps.
2. Tell me when you would like the test to start.

Jump test

Perform three countermovement jumps for each test, repeat any trial that has acquisition errors. Ensure the platform is collecting an accurate weight by resetting the measurement to zero just before the subject steps on the force plate. Read the following instructions:

Jump Standard Text (x3)

1) We would like you to jump straight into the air, as high as possible, using both legs. We will do three separate jumps.
2) Start by standing upright with your arms at your side, feet a shoulder width apart, one foot on each half of the force plate.
3) Stand still until you hear a beep.
4) Once that single beep occurs you can jump. Begin the jump by bending your knees, then push off the force plate and jump as high as you can.
5) Land with one foot on each half of the platform and, after regaining your balance, stand upright as still as possible; try not to land with your weight on your heels.
6) Once you hear two beeps the test is over.
7) Do you have any questions?