Component Description

Users of the 2013-2014 dual-energy X-ray absorptiometry femur bone data (DXXFEM\_H) are encouraged to read the documentation before accessing the data file.

Dual-energy x-ray absorptiometry (DXA) is the most widely accepted method of measuring bone density due in part to its speed, ease of use, and low radiation exposure (Baran, 1997; Genant, 1996; Heymfield, 1989; Njeh, 1999). DXA scans of the proximal femur were administered in the NHANES mobile examination center (MEC) in 2005 through 2010 and in 2013-14.

The femur scans provide bone measurements for the total femur, femoral neck, trochanter, intertrochanter, and Ward’s triangle. Measurements include:

* Bone mineral content (BMC) (gm)
* Bone area (cm2)
* Bone mineral density (BMD) (gm/cm2)

Eligible Sample

DXA scans were administered to eligible survey participants 40 years and older. Pregnant females were ineligible for the DXA examination. Participants who were excluded from the DXA examination for reasons other than pregnancy were considered to be eligible nonrespondents. Reasons for exclusion from the DXA examination were as follows:

* Pregnancy (positive urine pregnancy test and/or self-report at the time of the DXA examination).
* Self-reported history of radiographic contrast material such as dyes or barium in the past 7 days.
* Measured weight over 450 pounds (DXA table limitation).

The left hip was routinely scanned unless the participant self-reported a fractured left hip, a left hip replacement, or a pin in the left hip. The right hip was scanned in this situation. Participants were excluded from the femur scan if they had fractured both hips, had replacements of both hips, or had pins in both hips.

The variable DXAFMRST indicates the examination status for the femur scan; the codes for DXAFMRST are as follows:

DXAFMRST – femur scan examination status variable  
1 = Femur scan completed   
2 = Femur scan completed, but all data are invalid  
3 = Femur not scanned, pregnancy  
4 = Femur not scanned, weight > 450 lbs  
5 = Femur not scanned, other reason

The main reason for completed, but invalid, femur scans was panniculus, an “apron” or redundant layer of fat tissue at the lowest portion of the abdominal wall. The “Not scanned, other reason” code includes no time to complete the examination, pregnancy test not completed, and participant refusal, as well as exclusion for reasons other than pregnancy, such as a medical test.

Protocol and Procedure

The 2013-2014 femur scans were acquired on Hologic QDR-4500A fan-beam densitometers (Hologic, Inc., Bedford, Massachusetts) using software version Apex 3.2. The radiation exposure from DXA for the femur scan is extremely low at less than 20 uSv. All scans in the DXXFEM\_H file were analyzed with Hologic APEX version 4.0 software.

The DXA examinations were administered by trained and certified radiology technologists. Further details of the DXA examination protocol are documented in the Body Composition Procedures Manual located on the NHANES website (<https://www.cdc.gov/nchs/nhanes/index.htm>).

Quality Assurance & Quality Control

A high level of quality control was maintained throughout the DXA data collection and scan analysis, including a rigorous phantom scanning schedule.

**Monitoring of Field Staff and Densitometers**   
Staff from the National Center for Health Statistics (NCHS) and the NHANES data collection contractor monitored technologist acquisition performance through in-person observations in the field. Retraining sessions were conducted with the technologists annually and as needed to reinforce correct techniques and appropriate protocol. In addition, technologist performance codes were recorded by the NHANES quality control center at the University of California, San Francisco (UCSF), Department of Radiology during review of participant scans. The codes documented when the technologist had deviated from acquisition procedures and where scan quality could have been improved. The performance codes were tracked for each technologist individually and a summary reported to NCHS on a quarterly basis. Additional feedback on technologist performance was provided by the UCSF when problems were noted during review of the scans. Constant communication was maintained throughout the year among the UCSF, the NCHS, and the data collection contractor regarding any issues that arose.

Hologic service engineers performed all routine densitometer maintenance and repairs. Copies of all reports completed by the manufacturer’s service engineers were sent to the UCSF when the scanners were serviced or repaired so any changes in measurement as a result of the work could be assessed.

**Scan Analysis**  
Each participant and phantom scan was reviewed and analyzed by the UCSF using standard radiologic techniques and study-specific protocols developed for the NHANES. The most recently released Hologic software, APEX v4.0 (Hologic) was used to analyze all femur scans acquired in 2013-14. Expert review was conducted by the UCSF on 100% of analyzed participant scans to verify the accuracy and consistency of the results.

**Invalidity Codes**  
Invalidity codes were applied by the UCSF to indicate the reasons femur and spine regions of interest (ROI) could not be analyzed accurately. The invalidity codes are provided in the data file (see Data Processing and Editing section for a more detailed description of the invalidity codes).

**Quality Control Scans**   
The quality control phantoms were scanned according to a predetermined schedule. The Hologic Anthropomorphic Spine Phantom that traveled with each MEC was scanned daily as required by the manufacturer to ensure accurate calibration of the densitometer. The Hologic Femur Phantom was scanned once each week. A Hologic Spine (HSP-Q96) and a Hologic Block Phantom circulated among the MECs and were scanned at the start of operations at each survey site.

The complete phantom scanning schedule is described in the Body Composition Procedures Manual located on the NHANES website.

In 2013-2014, longitudinal monitoring was conducted through the daily spine phantom scans as required by the manufacturer and the once weekly femur phantom scans in order to correct any scanner-related changes in participant data. The circulating HSP-Q96 and block phantoms, which were scanned at the start of operations at each site, provided additional data for use in longitudinal monitoring and cross calibration.

The UCSF used the Cumulative Statistics method (CUSUM) and the MEC-specific phantom data to determine breaks in the calibration of the densitometers over the course of the survey (Lu, 1996). No shifting or drifting of the MEC-specific spine phantom values was found for any of the three MECs during 2013-2014. Therefore no corrections to the participant data were made.

A number of data quality issues were addressed through the quality control program. Direct feedback, given to the technologists regarding acquisition problems affecting the quality of the scans, and yearly refresher training resulted in improved technologist performance. The rigorous schedule of quality control scans provided continuous monitoring of machine performance. The expert review procedures assured that scan analysis was accurate and consistent.

Data Processing and Editing

During the editing process, data were reviewed for completeness, consistency, and outliers. Edits of the data were performed when errors were identified.

**Invalidity Codes**  
Invalidity codes are included in the data file to indicate the reasons femur regions of interest (ROI) could not be analyzed accurately. Invalidity codes are applicable to completed scans only (DXAFMRST=1 or 2). If a participant was not scanned, all invalidity codes are missing.

The invalidity codes are provided in the data file as follows:

Values for invalidity code DXXFMBCC (Total femur BMD)

0 = Valid data  
1 = Jewelry or other objects not removed   
2 = Non-removable objects such as implants  
3 = Excessive x-ray “noise” due to obesity  
4 = Body parts out of scan region  
5 = Positioning problem   
6 = Other (includes panniculus, participant motion, unknown artifacts)

The total femur BMD was coded as invalid (DXXFMBCC = 1-6) and all femur data set to missing if data for any femur subregion was invalid. Specifically, validity codes were provided for the femoral neck and trochanter by the quality control center because these are the femur regions that have been used the most in clinical situations. However, if either of these regions was invalid, the intertrochanter and Ward's triangle were also considered invalid. The 2007 Official Positions of the International Society for Clinical Densitometry (ISCD) state that only the femoral neck or total femur regions of interest should be used for diagnosis of osteoporosis at the femur (2007 ISCD Official Positions).

Analytic Notes

The NHANES examination sample weights should be used for any analyses using the DXXFEM\_H data. Please refer to the Analytic Guidelines on the NHANES website for further details on the use of sample weights and other analytic issues.

References

* Genant HK, Engelke K, Fuerst T, Güer C-C, Grampp S, Harris ST, Jergas M, Lang T, Lu Y, Majumdar S, Mathur A, Takada M.  Noninvasive assessment of bone mineral and structure: state of the art. J Bone Miner Res 1996;11:707-30.
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* Hololgic Product Support: Discovery.

<http://www.hologic.com/en/product-support/bone-densitometry/discovery/> [Accessed on: ]

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* Njeh CF, Fuerst T, Hans D, Blake GM, Genant HK. Radiation exposure in bone mineral density assessment.  Appl Radiat Isot 1999;50:215-36.

Codebook and Frequencies

SEQN - Respondent sequence number

**Variable Name:**

SEQN

**SAS Label:**

Respondent sequence number

**English Text:**

Respondent sequence number.

**Target:**

Both males and females 40 YEARS - 150 YEARS

DXAFMRST - Femur scan status

**Variable Name:**

DXAFMRST

**SAS Label:**

Femur scan status

**English Text:**

Femur scan status

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 1 | Femur scan completed, all data are valid | 3127 | 3127 |  |
| 2 | Femur scan completed, but all data are invalid | 176 | 3303 |  |
| 3 | Femur not scanned, pregnant | 3 | 3306 |  |
| 4 | Femur not scanned, weight > 450 lbs | 1 | 3307 |  |
| 5 | Femur not scanned, other reason | 401 | 3708 |  |
| . | Missing | 0 | 3708 |  |

DXXFMBCC - Total femur BMD invalidity code

**Variable Name:**

DXXFMBCC

**SAS Label:**

Total femur BMD invalidity code

**English Text:**

Total femur BMD invalidity code

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0 | Valid data | 3127 | 3127 |  |
| 1 | Jewelry or other objects not removed | 0 | 3127 |  |
| 2 | Non-removable objects such as implants | 4 | 3131 |  |
| 3 | Excessive x-ray noise due to obesity | 0 | 3131 |  |
| 4 | Body parts out of scan region | 3 | 3134 |  |
| 5 | Positioning problem | 0 | 3134 |  |
| 6 | Other (includes panniculus, participant motion, unknown artifact) | 169 | 3303 |  |
| . | Missing | 405 | 3708 |  |

DXXOFBMD - Total femur BMD

**Variable Name:**

DXXOFBMD

**SAS Label:**

Total femur BMD

**English Text:**

Total femur BMD

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0.362 to 1.563 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXXOFBMC - Total femur BMC

**Variable Name:**

DXXOFBMC

**SAS Label:**

Total femur BMC

**English Text:**

Total femur BMC

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 12.7 to 79.51 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXXOFA - Total femur area

**Variable Name:**

DXXOFA

**SAS Label:**

Total femur area

**English Text:**

Total femur area

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 23.88 to 83.09 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXXNKBMD - Femoral neck BMD

**Variable Name:**

DXXNKBMD

**SAS Label:**

Femoral neck BMD

**English Text:**

Femoral neck BMD

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0.386 to 1.361 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXXNKBMC - Femoral neck BMC

**Variable Name:**

DXXNKBMC

**SAS Label:**

Femoral neck BMC

**English Text:**

Femoral neck BMC

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 1.72 to 8.11 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXXNKA - Femoral neck area

**Variable Name:**

DXXNKA

**SAS Label:**

Femoral neck area

**English Text:**

Femoral neck area

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 3.08 to 7.1 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXXTRBMD - Trochanter BMD

**Variable Name:**

DXXTRBMD

**SAS Label:**

Trochanter BMD

**English Text:**

Trochanter BMD

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0.291 to 1.216 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXXTRBMC - Trochanter BMC

**Variable Name:**

DXXTRBMC

**SAS Label:**

Trochanter BMC

**English Text:**

Trochanter BMC

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 3.3 to 20.45 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXXTRA - Trochanter area

**Variable Name:**

DXXTRA

**SAS Label:**

Trochanter area

**English Text:**

Trochanter area

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 6.77 to 22.47 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXXINBMD - Intertrochanter BMD

**Variable Name:**

DXXINBMD

**SAS Label:**

Intertrochanter BMD

**English Text:**

Intertrochanter BMD

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0.389 to 1.802 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXXINBMC - Intertrochanter BMC

**Variable Name:**

DXXINBMC

**SAS Label:**

Intertrochanter BMC

**English Text:**

Intertrochanter BMC

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 7.08 to 65.7 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXXINA - Intertrochanter area

**Variable Name:**

DXXINA

**SAS Label:**

Intertrochanter area

**English Text:**

Intertrochanter area

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 11.82 to 61.47 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXXWDBMD - Wards triangle BMD

**Variable Name:**

DXXWDBMD

**SAS Label:**

Wards triangle BMD

**English Text:**

Wards triangle BMD

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0.162 to 1.402 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXXWDBMC - Wards triangle BMC

**Variable Name:**

DXXWDBMC

**SAS Label:**

Wards triangle BMC

**English Text:**

Wards triangle BMC

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0.18 to 1.81 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXXWDA - Wards triangle area

**Variable Name:**

DXXWDA

**SAS Label:**

Wards triangle area

**English Text:**

Wards triangle area

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0.82 to 1.31 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXAFMRK - Calculated K for femur

**Variable Name:**

DXAFMRK

**SAS Label:**

Calculated K for femur

**English Text:**

Calculated K for femur

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 1.1207 to 1.1738 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |

DXAFMRD0 - Calculated DO for femur

**Variable Name:**

DXAFMRD0

**SAS Label:**

Calculated DO for femur

**English Text:**

Calculated DO for femur

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 36.5708 to 54.2636 | Range of Values | 3127 | 3127 |  |
| . | Missing | 581 | 3708 |  |