Component Description

Users of the 2013-2014 dual-energy X-ray absorptiometry spine bone data (DXXSPN\_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; Heymsfield, 1989; and Njeh, 1999). Beginning in 2005, DXA scans of the lumbar spine have been administered in the NHANES mobile examination center (MEC).

The spine scans provide bone measurements for the total spine and vertebrae L1 – L4. 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 of age 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 (barium) use in past 7 days.
* Self-reported weight over 450 pounds (DXA table limitation).

Participants were excluded from the spine scan if they reported a Harrington Rod in the spine for scoliosis.

The variable DXASPNST indicates the examination status for the spine scan. The codes for DXASPNST are as follows:

DXASPNST – spine scan examination status variable   
1 = Spine scan completed and total spine BMD is valid  
2 = Spine scan completed, but all data are invalid  
3 = Spine not scanned, pregnancy  
4 = Spine not scanned, weight > 450 lbs  
5 = Spine not scanned, other reason

The main reasons for completed, but invalid, spine scans were an insufficient scan area or partial scan, degenerative disease/severe scoliosis, and sclerotic spine/spinal fusion/laminectomy. 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 spine scans were acquired on Hologic Discovery model A densitometers (Hologic, Inc., Bedford, Massachusetts), using software version Apex 3.2. The radiation exposure from DXA for the spine scan is extremely low at less than 20 uSv. All scans in the DXXSPN\_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 was 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. Ongoing 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 scan 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 spine 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 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) Phantom 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 daily spine phantom scans as required by the manufacturer and through 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 needed. Comparison of data for the phantoms that circulated among the MECs indicated no statistically significant differences so that data from the three MECs could be combined.

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 helped to ensure that scan analysis was accurate and consistent.

Data Processing and Editing

During the editing process, data were reviewed for completeness, consistency, and outliers. Back-end edits of the data were performed when errors were identified.

**Invalidity Codes**   
Invalidity codes were included in the data file to indicate the reasons and spine regions of interest (ROI) could not be analyzed accurately. Invalidity codes were applicable to completed scans only (DXASPNST = 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:

Invalidity codes

DXXOSBCC = total spine BMD  
DXXL1BCC = L1 vertebra BMD  
DXXL2BCC = L2 vertebra BMD  
DXXL3BCC = L3 vertebra BMD  
DXXL4BCC = L4 vertebra BMD

Values for DXXL1BCC, DXXL2BCC, DXXL3BCC, DXXL4BCC

0 = Valid data  
1 = Objects not removed   
2 = Non-removable objects such as implants  
3 = Excessive x-ray “noise” due to obesity  
4 = Insufficient scan area  
5 = Movement  
6 = (degenerative diseases, spinal fusion, fractures)

Values for DXXOSBCC

0 = valid data  
1 = invalid data

If one or more spine vertebrae were coded as invalid, total spine BMD was coded as invalid (DXXOSBCC = 1) and all spine data were set to missing.

Analytic Notes

The NHANES examination sample weights should be used for any analyses using the DXXSPN\_H data. Please refer to the NHANES Analytic Guidelines and the on-line NHANES Tutorial for further details on the use of sample weights and other analytic issues. Both of these are available on the NHANES website.(<https://www.cdc.gov/nchs/nhanes/index.htm>).

References

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* 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

DXASPNST - Spine scan status

**Variable Name:**

DXASPNST

**SAS Label:**

Spine scan status

**English Text:**

Spine scan status

**Target:**

Both males and females 40 YEARS - 150 YEARS

**Hard Edits:**

to

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 1 | Spine scan completed, all vertebrae are valid | 2135 | 2135 |  |
| 2 | Spine scan completed, but one or more vertebrae are invalid | 1209 | 3344 |  |
| 3 | Spine not scanned, pregnancy | 3 | 3347 |  |
| 4 | Spine not scanned, weight > 450 lbs | 1 | 3348 |  |
| 5 | Spine not scanned, other reason | 360 | 3708 |  |
| . | Missing | 0 | 3708 |  |

DXXOSBCC - Total spine BMD invalidity code

**Variable Name:**

DXXOSBCC

**SAS Label:**

Total spine BMD invalidity code

**English Text:**

Total spine 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 | 2135 | 2135 |  |
| 1 | Invalid data | 1209 | 3344 |  |
| . | Missing | 364 | 3708 |  |

DXXL1BCC - L1 BMD invalidity code

**Variable Name:**

DXXL1BCC

**SAS Label:**

L1 BMD invalidity code

**English Text:**

L1 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 | 3063 | 3063 |  |
| 1 | Objects not removed | 0 | 3063 |  |
| 2 | Non-removable objects such as implants | 26 | 3089 |  |
| 3 | Excessive x-ray noise due to morbid obesity | 0 | 3089 |  |
| 4 | Insufficient scan area | 3 | 3092 |  |
| 5 | Movement | 0 | 3092 |  |
| 6 | Other (degenerative diseases, spinal fusion, fractures) | 252 | 3344 |  |
| . | Missing | 364 | 3708 |  |

DXXL2BCC - L2 BMD invalidity code

**Variable Name:**

DXXL2BCC

**SAS Label:**

L2 BMD invalidity code

**English Text:**

L2 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 | 2836 | 2836 |  |
| 1 | Objects not removed | 0 | 2836 |  |
| 2 | Non-removable objects such as implants | 20 | 2856 |  |
| 3 | Excessive x-ray noise due to morbid obesity | 0 | 2856 |  |
| 4 | Insufficient scan area | 3 | 2859 |  |
| 5 | Movement | 1 | 2860 |  |
| 6 | Other (degenerative diseases, spinal fusion, fractures) | 484 | 3344 |  |
| . | Missing | 364 | 3708 |  |

DXXL3BCC - L3 BMD invalidity code

**Variable Name:**

DXXL3BCC

**SAS Label:**

L3 BMD invalidity code

**English Text:**

L3 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 | 2735 | 2735 |  |
| 1 | Objects not removed | 0 | 2735 |  |
| 2 | Non-removable objects such as implants | 35 | 2770 |  |
| 3 | Excessive x-ray noise due to morbid obesity | 0 | 2770 |  |
| 4 | Insufficient scan area | 3 | 2773 |  |
| 5 | Movement | 1 | 2774 |  |
| 6 | Other (degenerative diseases, spinal fusion, fractures) | 570 | 3344 |  |
| . | Missing | 364 | 3708 |  |

DXXL4BCC - L4 BMD invalidity code

**Variable Name:**

DXXL4BCC

**SAS Label:**

L4 BMD invalidity code

**English Text:**

L4 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 | 2637 | 2637 |  |
| 1 | Objects not removed | 0 | 2637 |  |
| 2 | Non-removable objects such as implants | 56 | 2693 |  |
| 3 | Excessive x-ray noise due to morbid obesity | 0 | 2693 |  |
| 4 | Insufficient scan area | 3 | 2696 |  |
| 5 | Movement | 1 | 2697 |  |
| 6 | Other (degenerative diseases, spinal fusion, fractures) | 647 | 3344 |  |
| . | Missing | 364 | 3708 |  |

DXXOSBMD - Total spine BMD

**Variable Name:**

DXXOSBMD

**SAS Label:**

Total spine BMD

**English Text:**

Total spine BMD

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0.517 to 1.693 | Range of Values | 2135 | 2135 |  |
| . | Missing | 1573 | 3708 |  |

DXXOSBMC - Total spine BMC

**Variable Name:**

DXXOSBMC

**SAS Label:**

Total spine BMC

**English Text:**

Total spine BMC

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 26.15 to 132.96 | Range of Values | 2135 | 2135 |  |
| . | Missing | 1573 | 3708 |  |

DXXOSA - Total spine area

**Variable Name:**

DXXOSA

**SAS Label:**

Total spine area

**English Text:**

Total spine area

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 37.75 to 87.77 | Range of Values | 2135 | 2135 |  |
| . | Missing | 1573 | 3708 |  |

DXXL1BMD - L1 BMD

**Variable Name:**

DXXL1BMD

**SAS Label:**

L1 BMD

**English Text:**

L1 BMD

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0.406 to 1.984 | Range of Values | 3063 | 3063 |  |
| . | Missing | 645 | 3708 |  |

DXXL1BMC - L1 BMC

**Variable Name:**

DXXL1BMC

**SAS Label:**

L1 BMC

**English Text:**

L1 BMC

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 4.88 to 37.6 | Range of Values | 3063 | 3063 |  |
| . | Missing | 645 | 3708 |  |

DXXL1A - L1 area

**Variable Name:**

DXXL1A

**SAS Label:**

L1 area

**English Text:**

L1 area

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 8.26 to 21.91 | Range of Values | 3063 | 3063 |  |
| . | Missing | 645 | 3708 |  |

DXXL2BMD - L2 BMD

**Variable Name:**

DXXL2BMD

**SAS Label:**

L2 BMD

**English Text:**

L2 BMD

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0.456 to 1.664 | Range of Values | 2836 | 2836 |  |
| . | Missing | 872 | 3708 |  |

DXXL2BMC - L2 BMC

**Variable Name:**

DXXL2BMC

**SAS Label:**

L2 BMC

**English Text:**

L2 BMC

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 5.39 to 32.1 | Range of Values | 2836 | 2836 |  |
| . | Missing | 872 | 3708 |  |

DXXL2A - L2 area

**Variable Name:**

DXXL2A

**SAS Label:**

L2 area

**English Text:**

L2 area

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 8.31 to 22.94 | Range of Values | 2836 | 2836 |  |
| . | Missing | 872 | 3708 |  |

DXXL3BMD - L3 BMD

**Variable Name:**

DXXL3BMD

**SAS Label:**

L3 BMD

**English Text:**

L3 BMD

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0.448 to 1.765 | Range of Values | 2735 | 2735 |  |
| . | Missing | 973 | 3708 |  |

DXXL3BMC - L3 BMC

**Variable Name:**

DXXL3BMC

**SAS Label:**

L3 BMC

**English Text:**

L3 BMC

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 5.93 to 37.34 | Range of Values | 2735 | 2735 |  |
| . | Missing | 973 | 3708 |  |

DXXL3A - L3 area

**Variable Name:**

DXXL3A

**SAS Label:**

L3 area

**English Text:**

L3 area

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 9.56 to 23.58 | Range of Values | 2735 | 2735 |  |
| . | Missing | 973 | 3708 |  |

DXXL4BMD - L4 BMD

**Variable Name:**

DXXL4BMD

**SAS Label:**

L4 BMD

**English Text:**

L4 BMD

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0.465 to 1.934 | Range of Values | 2637 | 2637 |  |
| . | Missing | 1071 | 3708 |  |

DXXL4BMC - L4 BMC

**Variable Name:**

DXXL4BMC

**SAS Label:**

L4 BMC

**English Text:**

L4 BMC

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 7.08 to 38.24 | Range of Values | 2637 | 2637 |  |
| . | Missing | 1071 | 3708 |  |

DXXL4A - L4 area

**Variable Name:**

DXXL4A

**SAS Label:**

L4 area

**English Text:**

L4 area

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 10.04 to 27.27 | Range of Values | 2637 | 2637 |  |
| . | Missing | 1071 | 3708 |  |

DXASPNK - Calculated K for spine

**Variable Name:**

DXASPNK

**SAS Label:**

Calculated K for spine

**English Text:**

Calculated K for spine

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 1.1134 to 1.1739 | Range of Values | 3344 | 3344 |  |
| . | Missing | 364 | 3708 |  |

DXASPND0 - Calculated DO for spine

**Variable Name:**

DXASPND0

**SAS Label:**

Calculated DO for spine

**English Text:**

Calculated DO for spine

**Target:**

Both males and females 40 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 34.1941 to 50.3385 | Range of Values | 3344 | 3344 |  |
| . | Missing | 364 | 3708 |  |