

# National Health and Nutrition Examination Survey

## 2017-March 2020 Data Documentation, Codebook, and Frequencies

### Dual-Energy X-ray Absorptiometry - Spine (P\_DXXSPN)

**Data File:** P\_DXXSPN.xpt

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## Component Description

The NHANES program suspended field operations in March 2020 due to the coronavirus disease 2019 (COVID-19) pandemic. As a result, data collection for the NHANES 2019-2020 cycle was not completed and the collected data are not nationally representative. Therefore, data collected from 2019 to March 2020 were combined with data from the NHANES 2017-2018 cycle to form a nationally representative sample of NHANES 2017-March 2020 pre-pandemic data. These data are available to the public. Please refer to the Analytic Notes section for more details on the use of the data.

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). DXA scans of the lumbar spine have been administered in the NHANES mobile examination center (MEC) from 2005-2010, 2013-2014, and 2017-March 2020.

The spine scans provide bone measurements for the total spine and vertebrae L1 – L4. Measurements include:

- Bone mineral content (BMC) (gm)
- Bone area (cm<sup>2</sup>)
- Bone mineral density (BMD) (gm/cm<sup>2</sup>)

## Eligible Sample

All participants aged 50 years and over, in the NHANES 2017-March 2020 pre-pandemic sample were eligible. Pregnant females were excluded from the DXA examination. Participants who were excluded from the DXA examination for reasons other than pregnancy were 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.
- Measured 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 all vertebrae are valid

2 = Spine scan completed, but one or more vertebrae are invalid

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.

## Protocol and Procedure

In 2017-18, the spine scans were acquired on Hologic Discovery model A densitometers (Hologic, Inc., Bedford, Massachusetts), using software version Apex 3.2. In 2019-March 2020, the spine scans were acquired on Hologic Horizon model A densitometers (Hologic, Inc., Bedford, Massachusetts), using software version Apex version 5.6.0.5. The radiation exposure from DXA for the spine scan is extremely low at less than 20 uSv. All scans in the P\_DXXSPN 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 on the [NHANES website](#).

## 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 Shepherd Research Lab at the University of California, San Francisco (UCSF), Department of Radiology (2017) and at the University of Hawaii (UH) Cancer Center (2018-Mar 2020) 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 Shepherd Research Lab when problems were noted during review of the scans. Constant communication was maintained throughout the year among the Shepherd Research Lab, 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 quality control center when the scanners were serviced or repaired so any changes in measurement as a result of the work could be assessed.

In 2019, three new DXA densitometer systems (Hologic Horizon Model A) were installed in the MECs. A cross calibration study was conducted to assure accuracy of NHANES longitudinal assessment. We followed International Society for Clinical Densitometry (ISCD) recommendations in replacing a bone densitometer unit within the same model and included both phantoms and human subjects in the study (ISCD DXA Machine Cross Calibration Tool). The spine bone mineral density values in the new instrument were within 1% of the prior instrument.

### Scan Analysis

Each participant scan and phantom scan was reviewed and analyzed by the Shepherd Research Lab using standard radiologic techniques and study-specific protocols developed for the NHANES. The Hologic software, APEX version 4.0 (Hologic) was used to analyze all spine scans acquired in 2017-Mar 2020. Expert review was conducted by the Shepherd Research Lab on 100% of analyzed participant scans to verify the accuracy and consistency of the results.

### Invalidity Codes

Invalidity codes were applied by the Shepherd Research Lab 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 on the NHANES website.

In 2017-Mar 2020, 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 Shepherd Research Lab 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 2017-Mar 2020. 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.

Several 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 = Removable or non-removable objects

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 COVID-19 pandemic required suspension of NHANES 2019-2020 field operations in March 2020 after data were collected in 18 of the 30 survey locations in the 2019-2020 sample. Because the collected data from 18 locations were not nationally representative, these data were combined with data from the previous cycle (2017-2018) to create a 2017-March 2020 pre-pandemic data file. A special weighting process was applied to the 2017-March 2020 pre-pandemic data file. The resulting exam sample weights in the demographic data file should be used to calculate estimates from the combined cycles. These exam sample weights are not appropriate for independent analyses of the 2019-2020 data and will not yield nationally representative results for either the 2017-2018 data alone or the 2019-March 2020 data alone. Please refer to the NHANES website for additional information for the NHANES 2017-March 2020 pre-pandemic data, and for the previous 2017-2018 public use data file with specific weights for that 2-year cycle.

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](#).

## References

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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

<b>Variable Name:</b>	SEQN
<b>SAS Label:</b>	Respondent sequence number
<b>English Text:</b>	Respondent sequence number.
<b>Target:</b>	Both males and females 50 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 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
1	Spine scan completed, all vertebrae are valid	2121	2121	
2	Spine scan completed, but one or more vertebrae are invalid	1792	3913	
4	Spine not scanned, weight > 450 lbs	3	3916	
5	Spine not scanned, other reason	677	4593	
.	Missing	0	4593	

## 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 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	Valid data	2121	2121	
1	Invalid data	1792	3913	
.	Missing	680	4593	

## 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 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	Valid data	3572	3572	
1	Removable or non-removable objects	23	3595	
3	Excessive x-ray noise due to morbid obesity	0	3595	
4	Insufficient scan area	10	3605	
5	Movement	4	3609	
6	Other (degenerative diseases, spinal fusion, fractures)	304	3913	
.	Missing	680	4593	



## 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 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	Valid data	3146	3146	
1	Removable or non-removable objects	36	3182	
3	Excessive x-ray noise due to morbid obesity	0	3182	
4	Insufficient scan area	0	3182	
5	Movement	6	3188	
6	Other (degenerative diseases, spinal fusion, fractures)	725	3913	
.	Missing	680	4593	

## 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 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	Valid data	3062	3062	
1	Removable or non-removable objects	45	3107	
3	Excessive x-ray noise due to morbid obesity	0	3107	
4	Insufficient scan area	0	3107	
5	Movement	4	3111	
6	Other (degenerative diseases, spinal fusion, fractures)	802	3913	
.	Missing	680	4593	

## 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 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	Valid data	2786	2786	
1	Removable or non-removable objects	58	2844	
3	Excessive x-ray noise due to morbid obesity	0	2844	
4	Insufficient scan area	2	2846	
5	Movement	5	2851	
6	Other (degenerative diseases, spinal fusion, fractures)	1062	3913	
.	Missing	680	4593	

## DXXOSBMD - Total spine BMD

**Variable Name:** DXXOSBMD  
**SAS Label:** Total spine BMD  
**English Text:** Total spine BMD  
**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.454 to 1.796	Range of Values	2121	2121	
.	Missing	2472	4593	

## DXXOSBMC - Total spine BMC

**Variable Name:** DXXOSBMC**SAS Label:** Total spine BMC**English Text:** Total spine BMC**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
10.19 to 141.42	Range of Values	2121	2121	
.	Missing	2472	4593	

## DXXOSA - Total spine area

**Variable Name:** DXXOSA  
**SAS Label:** Total spine area  
**English Text:** Total spine area  
**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
14.12 to 96.5	Range of Values	2121	2121	
.	Missing	2472	4593	

## DXXL1BMD - L1 BMD

**Variable Name:** DXXL1BMD**SAS Label:** L1 BMD**English Text:** L1 BMD**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0 to 1.697	Range of Values	3566	3566	
.	Missing	1027	4593	

## DXXL1BMC - L1 BMC

**Variable Name:** DXXL1BMC**SAS Label:** L1 BMC**English Text:** L1 BMC**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0 to 41.06	Range of Values	3566	3566	
.	Missing	1027	4593	



## DXXL1A - L1 area

**Variable Name:** DXXL1A**SAS Label:** L1 area**English Text:** L1 area**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0 to 25.31	Range of Values	3566	3566	
.	Missing	1027	4593	

## DXXL2BMD - L2 BMD

**Variable Name:** DXXL2BMD**SAS Label:** L2 BMD**English Text:** L2 BMD**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.461 to 1.796	Range of Values	3141	3141	
.	Missing	1452	4593	

## DXXL2BMC - L2 BMC

**Variable Name:** DXXL2BMC**SAS Label:** L2 BMC**English Text:** L2 BMC**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
5.26 to 46.46	Range of Values	3141	3141	
.	Missing	1452	4593	

## DXXL2A - L2 area

**Variable Name:** DXXL2A  
**SAS Label:** L2 area  
**English Text:** L2 area  
**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
7.23 to 27.1	Range of Values	3141	3141	
.	Missing	1452	4593	

## DXXL3BMD - L3 BMD

**Variable Name:** DXXL3BMD**SAS Label:** L3 BMD**English Text:** L3 BMD**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.461 to 2.101	Range of Values	3054	3054	
.	Missing	1539	4593	

## DXXL3BMC - L3 BMC

**Variable Name:** DXXL3BMC**SAS Label:** L3 BMC**English Text:** L3 BMC**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
4.76 to 44.01	Range of Values	3054	3054	
.	Missing	1539	4593	

## DXXL3A - L3 area

**Variable Name:** DXXL3A**SAS Label:** L3 area**English Text:** L3 area**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
7.71 to 25.39	Range of Values	3054	3054	
.	Missing	1539	4593	

## DXXL4BMD - L4 BMD

**Variable Name:** DXXL4BMD**SAS Label:** L4 BMD**English Text:** L4 BMD**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.452 to 2.864	Range of Values	2777	2777	
.	Missing	1816	4593	



## DXXL4BMC - L4 BMC

**Variable Name:** DXXL4BMC**SAS Label:** L4 BMC**English Text:** L4 BMC**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
5.43 to 64.47	Range of Values	2777	2777	
.	Missing	1816	4593	

## DXXL4A - L4 area

**Variable Name:** DXXL4A**SAS Label:** L4 area**English Text:** L4 area**Target:** Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
9.35 to 28.39	Range of Values	2777	2777	
.	Missing	1816	4593	

## 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 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
1.0961 to 1.1801	Range of Values	3903	3903	
.	Missing	690	4593	

## 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 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
33.1402 to 53.0471	Range of Values	3903	3903	
.	Missing	690	4593	