National Health and Nutrition Examination Survey

2017-March 2020 Data Documentation, Codebook, and Frequencies

Dual-Energy X-ray Absorptiometry - Femur (P_DXXFEM)

Data File: P_DXXFEM.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; Heymfield, 1989; Njeh, 1999). DXA scans of the proximal femur were administered in the NHANES mobile examination center (MEC) from 2005-2010, 2013-14 and 2017-March 2020.

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 (cm^2)
- Bone mineral density (BMD) (gm/cm^2)

Eligible Sample

All participants aged 50 years and over, in the NHANES 2017-March 2020 pre-pandemic sample were eligible. 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
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.

Protocol and Procedure

In 2017-18, the femur scans were acquired on Hologic Discovery model A densitometers (Hologic, Inc., Bedford, Massachusetts), using software version Apex 3.2. In 2019-March 2020, the femur 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 femur scan is extremely low at less than 20 uSv. All scans in the P_DXXFEM 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.

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 Shepherd Research Lab at the University of California, San Francisco (UCSF), Department of Radiology (2017) and at the University of Hawaii (UH) Cancer Center (2018-2020) 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 and phantom scan was reviewed and analyzed by the Shepherd Lab using standard radiologic techniques and study-specific protocols developed for the NHANES. The Hologic software, APEX v4.0 (Hologic) was used to analyze all femur 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 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 2017-Mar 2020, 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 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 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 = Removable or non-removable objects
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 sub region 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 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. The resulting exam sample weights in the demographic 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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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 50 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 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
1	Femur scan completed, all data are valid	3545	3545	
2	Femur scan completed, but all data are invalid	339	3884	
4	Femur not scanned, weight > 450 lbs	3	3887	
5	Femur not scanned, other reason	706	4593	
.	Missing	0	4593	

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 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	Valid data	3545	3545	
1	Removable or non-removable objects	6	3551	
3	Excessive x-ray noise due to obesity	1	3552	
4	Body parts out of scan region	1	3553	
5	Positioning problem	0	3553	
6	Other (includes panniculus, participant motion, unknown artifact)	331	3884	
.	Missing	709	4593	

DXXOFBMD - Total femur BMD

Variable Name: DXXOFBMD

SAS Label: Total femur BMD

English Text: Total femur BMD

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.37 to 1.611	Range of Values	3545	3545	
.	Missing	1048	4593	

DXXOFBMC - Total femur BMC

Variable Name: DXXOFBMC

SAS Label: Total femur BMC

English Text: Total femur BMC

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
13.42 to 91.5	Range of Values	3545	3545	
.	Missing	1048	4593	

DXXOFA - Total femur area

Variable Name: DXXOFA

SAS Label: Total femur area

English Text: Total femur area

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
23.16 to 61.86	Range of Values	3545	3545	
.	Missing	1048	4593	

DXXNKBMD - Femoral neck BMD

Variable Name: DXXNKBMD

SAS Label: Femoral neck BMD

English Text: Femoral neck BMD

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.144 to 1.703	Range of Values	3545	3545	
.	Missing	1048	4593	

DXXNKBMC - Femoral neck BMC

Variable Name: DXXNKBMC

SAS Label: Femoral neck BMC

English Text: Femoral neck BMC

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.14 to 10.77	Range of Values	3545	3545	
.	Missing	1048	4593	

DXXNKA - Femoral neck area

Variable Name: DXXNKA

SAS Label: Femoral neck area

English Text: Femoral neck area

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.31 to 7.46	Range of Values	3545	3545	
.	Missing	1048	4593	

DXXTRBMD - Trochanter BMD

Variable Name: DXXTRBMD

SAS Label: Trochanter BMD

English Text: Trochanter BMD

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0 to 1.263	Range of Values	3545	3545	
.	Missing	1048	4593	

DXXTRBMC - Trochanter BMC

Variable Name: DXXTRBMC

SAS Label: Trochanter BMC

English Text: Trochanter BMC

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0 to 33.78	Range of Values	3545	3545	
.	Missing	1048	4593	

DXXTRA - Trochanter area

Variable Name: DXXTRA

SAS Label: Trochanter area

English Text: Trochanter area

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0 to 39.46	Range of Values	3545	3545	
.	Missing	1048	4593	

DXXINBMD - Intertrochanter BMD

Variable Name: DXXINBMD

SAS Label: Intertrochanter BMD

English Text: Intertrochanter BMD

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.419 to 1.805	Range of Values	3545	3545	
.	Missing	1048	4593	

DXXINBMC - Intertrochanter BMC

Variable Name: DXXINBMC

SAS Label: Intertrochanter BMC

English Text: Intertrochanter BMC

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
7.79 to 61.16	Range of Values	3545	3545	
.	Missing	1048	4593	

DXXINA - Intertrochanter area

Variable Name: DXXINA

SAS Label: Intertrochanter area

English Text: Intertrochanter area

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
7.69 to 38.15	Range of Values	3545	3545	
.	Missing	1048	4593	

DXXWDBMD - Wards triangle BMD

Variable Name: DXXWDBMD

SAS Label: Wards triangle BMD

English Text: Wards triangle BMD

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0 to 1.542	Range of Values	3545	3545	
.	Missing	1048	4593	

DXXWDBMC - Wards triangle BMC

Variable Name: DXXWDBMC

SAS Label: Wards triangle BMC

English Text: Wards triangle BMC

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0 to 1.72	Range of Values	3545	3545	
.	Missing	1048	4593	

DXXWDA - Wards triangle area

Variable Name: DXXWDA

SAS Label: Wards triangle area

English Text: Wards triangle area

Target: Both males and females 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0 to 1.32	Range of Values	3545	3545	
.	Missing	1048	4593	

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 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
1.1125 to 1.1701	Range of Values	3545	3545	
.	Missing	1048	4593	

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 50 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
36.875 to 57.5368	Range of Values	3545	3545	
.	Missing	1048	4593	