

**National Health and Nutrition  
Examination Survey 2005–2006**

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**Documentation, Codebook,  
and Frequencies**

**Dual-Energy X-ray  
Absorptiometry – Femur Bone  
Measurements**

**Examination**

**Survey Years:  
2005 to 2006**

**SAS Transport File:  
DXXFEM\_D.XPT**



January 2009

# NHANES 2005–2006 Data Documentation

## Exam Component: Dual-Energy X-ray Absorptiometry - Femur Bone Measurements (DXXFEM\_D)

Years of Coverage: 2005–2006

First Published: January 2009

Last Revised: NA

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### Component Description

Users of the 2005-2006 dual-energy X-ray absorptiometry femur bone data (DXXFEM\_D) 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 (1-3). Beginning in 2005, DXA scans of the proximal femur have been administered in the NHANES mobile examination center (MEC).

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

The NHANES DXA femur bone measurements component provides nationally representative data on 1) femur bone mineral content, bone area, and bone mineral density and 2) estimates of the prevalence of osteoporosis.

### Eligible Sample

DXA scans were administered to eligible survey participants 8 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). Females between the ages of 12–59 years and menstruating 8–11 year olds were not permitted to take the DXA examination without a negative MEC pregnancy test result. In addition, females aged 12–59 years were excluded from the examination if they said they were

pregnant at the time of the exam, even if the pregnancy test was negative.

- Self-reported history of radiographic contrast material (barium) use in past 7 days.
- Self-reported nuclear medicine studies in the past 3 days.
- Self-reported weight over 300 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 > 300 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 femur scans were performed with a Hologic QDR-4500A fan-beam densitometer (Hologic, Inc., Bedford, Massachusetts). Hologic software version 8.26:a3\* was used to administer all scans through mid 2005. In 2005, the acquisition software was updated to Hologic Discovery v12.4. The radiation exposure from DXA for both the femur or spine scan is extremely low at less than 20 uSv.

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 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. No mechanical repairs were required for any of the three densitometers in 2005-06.

### **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. Hologic Discovery software, version 12.4, was used to analyze all scans acquired in 2005 and 2006. The Discovery analysis software incorporates the Auto Whole Body application, which was developed to improve bone detection in children participating in the NHANES and other studies of children (4, 5). 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 single Hologic Spine (HSP-Q96) and Hologic Block Phantoms 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 2005-2006, 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 (10). There were no break points for any of the three MECs in either the spine or femur phantom data during 2005-2006, and therefore no corrections to the participant data were needed. Comparison of data for the phantoms that circulated among the MECs indicated no significant differences so that data from the three MECs could be combined.

A number of 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. 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 femur regions of interest (ROI) could not be analyzed accurately. Invalidity codes were 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:

#### Invalidity code

DXXFMBCC = total femur BMD

#### Values for DXXFMBCC

- 0 = Valid data
- 1 = Jewelry or other objects not removed
- 2 = Non-removable objects (includes prostheses, 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 = 1-7) and all femur data set to missing if data for any femur subregion was invalid. In specific, 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 (6).

## Analytic Notes

The NHANES examination sample weights should be used for any analyses using the DXXBON\_D 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

1. 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.
2. Njeh CF, Fuerst T, Hans D, Blake GM, Genant HK. Radiation exposure in bone mineral density assessment. *Appl Radiat Isot* 1999;50:215-36.
3. Heymsfield SB, Wang J, Heshka S, Kehayias JJ, Pierson RN Jr. Dual-photon absorptiometry: comparison of bone mineral and soft tissue measurements in vivo with established methods. *Am J Clin Nutr* 1989;49:1283-9.
4. Baran DT, Faulkner KG, Genant HK, Miller PD, Pacifici R. Diagnosis and management of osteoporosis: guidelines for the utilization of bone densitometry. *Calcif Tissue Int* 1997;62:433-440.
5. Kelly, TL. Pediatric whole body measurements. *J Bone Min Res* 2002;17(suppl):S297.
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<http://www.iscd.org/Visitors/positions/OfficialPositionsText.cfm>

## Locator Record

**Title:** Dual Energy X-ray Absorptiometry – Femur Bone Measurements (DXXFEM\_D)

**Contact Number:** 1-866-441-NCHS

**Years of Content:** 2005–2006

**First Published:** January 2009

**Revised:** NA

**Access Constraints:** None

**Use Constraints:** None

**Geographic Coverage:** National

**Subject:** Personal examination data on proximal femur bone mineral content, bone area, and bone mineral density.

**Record Source:** NHANES 2005–2006

**Survey Methodology:** NHANES 2005–2006 is a stratified multistage probability sample of the civilian non-institutionalized population of the U.S.

**Medium:** NHANES Web site; SAS transport files

**National Health and Nutrition Examination Survey  
Codebook for Data Production (2005-2006)**

**Dual Energy X-ray – Femur Bone Measurements (DXXFEM\_D)  
Person Level Data**

January 2009



<b>SEQN</b>	<b>Target</b>
	B(8 Yrs. to 150 Yrs.)
<b>Hard Edits</b>	<b>SAS Label</b>
	Respondent sequence number
<b>English Text:</b> Respondent sequence number.	
<b>English Instructions:</b>	

<b>DXAFMRST</b>	<b>Target</b>
	B(8 Yrs. to 150 Yrs.)
<b>Hard Edits</b>	<b>SAS Label</b>
	Femur scan status
<b>English Text:</b> Femur scan status	
<b>English Instructions:</b>	

Code or Value	Description	Count	Cumulative	Skip to Item
1	Femur scan completed, all data are valid	6076	6076	
2	Femur scan completed, all data are invalid	362	6438	
3	Femur not scanned, pregnant	371	6809	
4	Femur not scanned, weight > 300 lbs	95	6904	
5	Femur not scanned, other reason	816	7720	
.	Missing	0	7720	

<b>DXXFMBCC</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Total femur BMD invalidity code			
<b>English Text:</b> Total femur BMD invalidity code				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
0	Valid data	6076	6076	
1	Jewelry or other objects not removed	0	6076	
2	Non-removable objects (includes prostheses, implants)	3	6079	
3	Excessive x-ray "noise" due to obesity	3	6082	
4	Body parts out of scan region	28	6110	
5	Positioning problem	3	6113	
6	Other (includes panniculus, participant motion, unknown artifacts)	325	6438	
.	Missing	1282	7720	

<b>DXXOFBMD</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Total femur BMD			
<b>English Text:</b> Total femur bone mineral density (gm/cm <sup>2</sup> )				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
0.378 to 1.821	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXXOFBMC</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Total femur BMC			
<b>English Text:</b> Total femur bone mineral content (gm)				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
7.54 to 83.85	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXXOFA</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Total femur area			
<b>English Text:</b> Total femur area (cm <sup>2</sup> )				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
14.55 to 58.27	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXXNKBMD</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Femoral neck BMD			
<b>English Text:</b> Femoral neck bone mineral density (gm/cm <sup>2</sup> )				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
0.359 to 1.643	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXXNKBMC</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Femoral neck BMC			
<b>English Text:</b> Femoral neck bone mineral content (gm)				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
1.42 to 10.08	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXXNKA</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Femoral neck area			
<b>English Text:</b> Femoral neck area (cm <sup>2</sup> )				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
2.63 to 8.03	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXXTRBMD</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Trochanter BMD			
<b>English Text:</b> Trochanter bone mineral density (gm/cm <sup>2</sup> )				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
0.293 to 1.594	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXXTRBMC</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Trochanter BMC			
<b>English Text:</b> Trochanter bone mineral content (gm)				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
1.08 to 21.09	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXXTRA</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Trochanter area			
<b>English Text:</b> Trochanter area (cm <sup>2</sup> )				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
2.82 to 19.2	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXXINBMD</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Intertrochanter BMD			
<b>English Text:</b> Intertrochanter bone mineral density (gm/cm <sup>2</sup> )				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
0.419 to 2.09	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXXINBMC</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Intertrochanter BMC			
<b>English Text:</b> Intertrochanter bone mineral content (gm)				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
4.59 to 55.63	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXXINA</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Intertrochanter area			
<b>English Text:</b> Intertrochanter area (cm <sup>2</sup> )				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
7.53 to 34.18	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXXWDBMD</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Ward's triangle BMD			
<b>English Text:</b> Ward's triangle bone mineral density (gm/cm <sup>2</sup> )				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
0.148 to 1.685	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXXWDBMC</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Ward's triangle BMC			
<b>English Text:</b> Ward's triangle bone mineral content (gm)				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
0.17 to 2.03	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXXWDA</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Ward's triangle area			
<b>English Text:</b> Ward's triangle area (cm <sup>2</sup> )				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
1.03 to 1.33	Range of Values	6076	6076	
.	Missing	1644	7720	

<b>DXAFMRK</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Calculated K for femur			
<b>English Text:</b> Calculated K for femur				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
1.113 to 1.1532	Range of Values	6425	6425	
.	Missing	1295	7720	

<b>DXAFMRD0</b>	<b>Target</b>			
	B(8 Yrs. to 150 Yrs.)			
<b>Hard Edits</b>	<b>SAS Label</b>			
	Calculated DO for femur			
<b>English Text:</b> Calculated DO for femur				
<b>English Instructions:</b>				
<b>Code or Value</b>	<b>Description</b>	<b>Count</b>	<b>Cumulative</b>	<b>Skip to Item</b>
41.0319 to 57.6299	Range of Values	6425	6425	
.	Missing	1295	7720	