
National Health Statistics Reports

Number 103 ■ March 28, 2017

FRAX-based Estimates of 10-year Probability of Hip and Major Osteoporotic Fracture Among Adults Aged 40 and Over: United States, 2013 and 2014

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Abstract

Background—The FRAX algorithm estimates the 10-year probability of hip and major osteoporotic (clinical spine, forearm, hip, or humerus) fracture for adults aged 40 and over. An expert panel developed criteria to define elevated FRAX probabilities for U.S. adults aged 50 and over. This report uses FRAX estimates from the National Health and Nutrition Examination Survey 2013–2014 to describe the hip and major osteoporotic fracture probability distribution (for adults aged 40 and over) and prevalence of elevated probabilities (for adults aged 50 and over) in the United States.

Methods—FRAX U.S. version 3.05 was used to calculate fracture probability from risk factors that were measured (i.e., femur neck bone mineral density, height, and weight) or self-reported (i.e., fracture history, glucocorticoid use, rheumatoid arthritis, smoking, and alcohol intake). Among adults aged 50 and over, elevated probabilities were defined as 3% or greater for hip fracture and 20% or greater for major osteoporotic fracture.

Results—Mean skew-adjusted fracture probabilities were 0.5% for hip fracture and 5.3% for major osteoporotic fracture among adults aged 40 and over, and 0.9% and 7.4%, respectively, among adults aged 50 and over. The percentages of adults aged 50 and over with an elevated hip or major osteoporotic fracture probability were 19% and 8%, respectively. Fracture probabilities varied significantly by age (older groups had higher probabilities than younger groups), sex (women had higher probabilities than men), and race and Hispanic origin (non-Hispanic white persons had higher probabilities than all other race and Hispanic groups) ($p < 0.001$). An estimated 95%–97% of adults aged 50 and over with an elevated probability of either fracture type had femoral neck osteoporosis or low bone mass.

Conclusions—Mean hip and major osteoporotic fracture probabilities were 0.5% and 5.3%, respectively, for adults aged 40 and over. Among adults aged 50 and over, mean hip and major osteoporotic fracture probabilities were 0.9% (19% with elevated values) and 7.4% (8% with elevated values), respectively.

Keywords: fracture risk prediction • osteoporosis • National Health and Nutrition Examination Survey (NHANES)

Introduction

Fractures due to osteoporosis are a serious concern in the United States due to their economic burden as well as their negative impact on health and well-being (1,2). Osteoporosis is currently defined on the basis of bone mineral density (BMD) (3) because BMD is a strong predictor of future fracture. However, many fractures occur in persons with BMD values that fall above the osteoporosis threshold (2). Thus, measuring BMD only partially identifies the population segment who are at risk of fracture.

To address this discrepancy, researchers at the World Health Organization (WHO) Collaborating Centre at Sheffield, United Kingdom, in the early 2000s developed a more global evaluation of fracture risk than that based on BMD alone (4). As part of the effort, a number of clinical risk factors that predict fracture independently of BMD (e.g., lifestyle and health history risk factors easily assessed in primary care settings) were identified and validated using data from a large number of international, prospective population-based cohorts (4). An algorithm, called FRAX, was then developed to integrate these risk factors with mortality data to estimate the 10-year absolute probability



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of hip and major osteoporotic (clinical spine, forearm, hip, or humerus) fracture among adults aged 40 and over (4). Risk factors used in the algorithm include age, sex, femur neck BMD, body mass index (BMI), prior fragility fracture, parental history of hip fracture, glucocorticoid use, rheumatoid arthritis, current smoking, excess alcohol consumption, and secondary osteoporosis. Separate FRAX algorithms have been developed for different countries using country-specific fracture and mortality data (4). The U.S. Food and Drug Administration has approved incorporating the FRAX algorithm into dual energy X-ray absorptiometry (DXA) systems so that FRAX estimates can be provided in addition to BMD results when DXA scans are performed (5–7). FRAX-based 10-year fracture probability estimates are currently used in many national and international osteoporosis guidelines (5,8), including several guidelines used in the United States (9–12). One of these U.S. guidelines, developed by the National Osteoporosis Foundation on the basis of a cost-effective analysis, includes criteria to define elevated fracture probabilities applicable to U.S. adults aged 50 and over (9).

Although FRAX-based estimates of 10-year fracture probabilities, or FRAX scores, are widely used in the United States, the distribution of these fracture probability scores among the adult U.S. population has not been previously described. This report provides detailed information about the FRAX score distribution for U.S. adults aged 40 and over using data from the National Health and Nutrition Examination Survey (NHANES) conducted in 2013 and 2014. Information on the prevalence of the risk factors used in the FRAX algorithm among adults aged 40 and over, and the prevalence of elevated FRAX scores among adults aged 50 and over, are also provided.

Methods

Data source

The present study used data collected in NHANES 2013–2014, which was conducted by the National Center for Health Statistics (NCHS) to assess the health and nutritional status of a representative sample of the noninstitutionalized, civilian U.S. population. A complex, multistage probability sample design was used to select the sample (13,14). NHANES collects data via household interviews and direct standardized physical examinations conducted in specially equipped mobile examination centers (14). All procedures in NHANES 2013–2014 were approved by the NCHS Research Ethics Review Board, and written informed consent was obtained from all participants. The unweighted examination response rate for adults aged 40 and over, the age range for which 10-year fracture probability scores were calculated, was 61% for NHANES 2013–2014.

The analytic sample was derived from the 3,708 adults aged 40 and over participating in NHANES 2013–2014 who received physical examinations. Of these, 581 (15.67%) were excluded because they lacked valid femur neck BMD, height, or weight data. The final main analytic sample consisted of 3,127 respondents.

Measures

BMD

Proximal femur scans were obtained via DXA using Hologic Discovery A densitometers (Hologic Inc., Marlborough, Mass.) in NHANES 2013–2014. The femur scans were analyzed with Apex 4.0 software. Details of the DXA examination protocol have been published elsewhere (15). Rigorous quality control (QC) programs were used to monitor DXA scanners. All QC and respondent scans were analyzed and reviewed by an expert at a central site (Department of Radiology at University of California, San Francisco [UCSF]) using standard radiologic techniques and

study-specific protocols developed for NHANES (15).

Femur neck BMD of adults aged 50 and over was categorized as normal, low bone mass, or osteoporosis using criteria recommended by WHO (16). T scores were calculated as:

$$\frac{\text{BMD}_{\text{respondent}} - \text{mean BMD}_{\text{reference group}}}{\text{Standard deviation}_{\text{reference group}}}$$

Normal was defined as a T score greater than -1.0 ; low bone mass as a T score between -1.0 and -2.5 ; and osteoporosis as a T score of -2.5 or less. Based on WHO recommendations, non-Hispanic white women aged 20–29 who participated in NHANES III (1988–1994) were used as the reference group for calculation of T scores at the femur neck (16).

Anthropometry

Body weight was measured to the nearest 0.01 kg using an electronic load cell scale, and standing height was measured with a fixed stadiometer. BMI was calculated as body weight (kilograms) divided by height (meters squared).

Clinical risk factors

The lifestyle and health history risk factors used to calculate the 10-year fracture probability scores, referred to as “clinical risk factors” by developers of the FRAX approach (4), were measured as follows:

- Previous fracture:** Two data sources were used to define previous fractures: a) self-reported fractures at any skeletal site that occurred after age 20; and b) presence of a vertebral fracture on the respondent’s Vertebral Fracture Assessment obtained via a lateral spine DXA scan performed on the Hologic Discovery A densitometer. Each vertebra between the fourth thoracic vertebra (T4) and the fourth lumbar spine vertebra (L4) was graded by a reader at the UCSF DXA QC site using Genant’s semiquantitative method (17). Fractured vertebrae were confirmed by an expert musculoskeletal radiologist

(Dr. Harry Genant). Respondents with vertebral fractures were defined using an approach recommended for NHANES 2013–2014 by an expert group (18). Specifically, a respondent was defined as “fractured” if a fracture was observed anywhere between T4 and L4, regardless if unevaluable vertebrae existed elsewhere. Respondents were defined as “not fractured” if no fracture was observed and at least 9 of 10 vertebrae between T7 and L4 were evaluable. T4–T6 were not required to be evaluable because they are difficult to visualize correctly and only a small proportion of vertebral fractures occur at these levels (19). Status was listed as “uninterpretable” for respondents not meeting these criteria.

- **Parental history of hip fracture:** Respondents who reported that either their biological mother or father had fractured their hip were considered to have a positive parental history.
- **Cigarette smoking and high alcohol intake:** Cigarette smokers were defined as respondents who self-reported that they currently smoked, while high alcohol users were defined as respondents who self-reported that they usually consumed three or more drinks per day when they drank alcohol, for consistency with the approach used for this variable in the FRAX model.
- **Glucocorticoid use:** Usage was based on self-report of having ever taken prednisone or cortisone nearly every day for 90 days or more.
- **Rheumatoid arthritis (RA):** Persons with RA were defined as those who self-reported having been told by a doctor that they had RA.
- **Other causes of secondary osteoporosis:** These were not included in the calculation of the 10-year fracture probability scores because they do not affect the scores when BMD is in the algorithm (4). Thus, this variable was recorded as “no” for all respondents.

FRAX-based estimates of 10-year fracture probability

Ten-year probability scores were calculated for hip and major osteoporotic fractures (involving hip, spine, proximal humerus, or distal forearm) using FRAX version 3.05 for the United States, which was available on the Hologic DXA system. This version provides separate algorithms for Caucasian, black, Hispanic, and Asian persons. Persons of other races were analyzed using the Caucasian algorithm in the present study. Race and Hispanic origin were self-reported by the participants. Persons with missing data for a clinical risk factor were assumed not to have that risk factor, as recommended on the FRAX website: <http://www.shef.ac.uk/FRAX>.

Elevated 10-year fracture probability scores were defined for respondents aged 50 and over in the present study using thresholds for intervention with osteoporosis medications that were recommended in the National Osteoporosis Foundation (NOF) guidelines for persons in this age range (9). An elevated 10-year probability score was defined as 3% or more for hip fracture and 20% or more for major osteoporotic fracture. These thresholds were based on a cost–benefit analysis that was performed to identify the 10-year fracture probability values required for osteoporosis treatments to be cost-effective for adults aged 50 and over in the United States (20,21).

Statistical analysis

Analyses were conducted with PC–SAS Version 9.3 (SAS Institute, Cary, N.C.) and SUDAAN Version 11.0.1 (RTI International, Research Triangle Park, N.C.). All analyses used the examination sample weights and accounted for the complex survey design when calculating statistical tests. Because the distributions of the 10-year probability scores for both hip and major osteoporotic fractures were skewed, the fracture probability scores were transformed before comparing means by age, sex, or race and Hispanic origin. Transformations were identified using Box–Cox analyses. Based on those results, hip fracture probability scores were raised to the fourth power, while a natural log

transformation was used for the major osteoporotic fracture probability scores. The transformed data were then back-transformed for presentation as means in the tables and figures. Specifically, transformed hip fracture probability values were raised to the one-fourth power, while the antilog of transformed major osteoporotic fracture probability values was used to calculate the geometric mean. Age-adjusted estimates shown in the detailed tables were age-adjusted to the 2000 census using the direct method and the following age groups: 40–49, 50–59, 60–69, 70–79, and 80 and over. Tests of statistical significance were performed using linear or logistic regression.

Missing data

Nonresponse bias analyses were conducted because 16% of the examined sample of adults aged 40 and over in NHANES 2013–2014 had been excluded from the main analytic sample due to missing femur neck BMD, height, or weight data. Excluded respondents were more likely to be female, older, shorter, weigh more, have a higher BMI, and self-reported their health status as fair or poor than respondents in the analytic sample. To further examine the potential for nonresponse bias, the publicly released examination sample weights were adjusted for item nonresponse using the PROC WTADJUST procedure in SUDAAN. This model-based calibration procedure was used to reweight the data by computing nonresponse and poststratification weight adjustments by age, sex, and race and Hispanic origin in order to adjust for biases associated with these variables. The adjusted sample weights resulted in similar conclusions to those seen when the publicly released examination sample weights were used; thus, only the latter results are shown.

Results

Population distribution of characteristics used in FRAX algorithms for ages 40 and over

Means and percentages of the characteristics used in the FRAX algorithms to calculate 10-year probability of hip and major osteoporotic fracture are shown in [Table A](#) for adults aged 40 and over from NHANES 2013–2014 by sex and as a total. Comparisons by race and Hispanic origin are not shown because sample sizes for the nonwhite groups were insufficient to provide statistically reliable estimates for many of the clinical risk factors.

Mean age was approximately 57 years, and mean BMI was roughly 29 kg/m² for adults aged 40 and over. Women were significantly older than men. Mean BMI did not differ significantly between men and women. However, mean femur neck BMD was significantly lower in women than in men, by 0.07 gm/cm², which corresponds to approximately 0.6 standard deviation units, or roughly a 27% difference in fracture risk (4).

Previous fracture (35%) was the most common clinical risk factor reported overall by adults aged 40 and over in 2013–2014, followed by drinking alcohol three or more times per day (19%) and current smoking (18%) ([Table A](#)). All other clinical risk factors used in the

FRAX algorithms were reported by 9% or less of these adults. The majority of adults in this age range (59%) reported having at least one of the clinical risk factors, with 6% reporting having three or more. The prevalence of the individual clinical risk factors, as well as the number of clinical risk factors, did not differ significantly between men and women with one exception: Men were significantly more likely than women to report consuming alcohol three times per day or more.

Table A. Characteristics used to calculate FRAX-based 10-year hip and major osteoporotic fracture probability scores for adults aged 40 and over: United States, 2013 and 2014

Characteristic	Both sexes			Men			Women		
	Sample size	Mean or percent	Standard error	Sample size	Mean or percent	Standard error	Sample size	Mean or percent	Standard error
Mean									
Mean age (years)	3,127	57.2	0.3	1,546	56.8	0.2	1,581	†57.7	0.4
Mean body mass index (kg/m ²)	3,127	28.8	0.2	1,546	28.9	0.2	1,581	28.8	0.3
Mean femur neck BMD (gm/cm ²)	3,127	0.779	0.003	1,546	0.815	0.004	1,581	†0.745	0.005
Clinical risk factor (percent)									
Currently smoke:									
Yes	575	17.7	1.6	316	17.8	1.3	259	17.5	2.3
No	2,552	82.3	1.6	1,230	82.2	1.3	1,322	82.5	2.3
Drink three alcoholic drinks or more per day:									
Yes	541	18.6	0.7	387	26.5	1.3	154	†10.9	1.0
No	2,586	81.4	0.7	1,159	73.5	1.3	1,427	89.1	1.0
Self-reported rheumatoid arthritis:									
Yes	161	4.6	0.4	65	3.7	0.6	96	5.4	0.8
No	2,966	95.4	0.4	1,481	96.3	0.6	1,485	94.6	0.8
Parent had a hip fracture:									
Yes	263	9.3	0.5	112	6.9	0.7	151	11.7	0.9
No	2,864	90.7	0.5	1,434	93.1	0.7	1,430	88.3	0.9
Glucocorticoid use for 3 months or more:									
Yes	103	3.3	0.5	40	2.3	0.6	63	4.3	0.5
No	3024	96.7	0.5	1,506	97.7	0.6	1,518	95.7	0.5
Previous fracture [†] :									
Yes	963	34.7	1.6	489	35.3	2.2	474	34.2	1.4
No	2,164	65.3	1.6	1,057	64.7	2.2	1,107	65.8	1.4
Number of clinical risk factors:									
None	1,385	40.9	1.2	625	38.6	1.4	760	43.1	1.6
One	1,084	36.6	1.0	556	37.3	1.3	528	35.9	1.1
Two	470	16.6	0.8	253	18.0	1.4	217	15.2	0.8
Three or more	188	6.0	1.0	112	6.1	1.0	76	5.8	1.0

† Significantly different from men, $p < 0.05$.

[†]Based on self-reported fractures and vertebral fractures measured via Vertebral Fracture Assessment from lateral dual-energy X-ray absorptiometry spine scans.

NOTES: FRAX-based 10-year fracture probability is an estimate of the likelihood of having a fracture during the next 10 years. It is based on age, sex, race and Hispanic origin, femur neck bone mineral density, body mass index, smoking, alcohol use, glucocorticoid use, personal and parental fracture history, and rheumatoid arthritis. BMD is bone mineral density.

Population distribution of FRAX-based estimates of 10-year probability of hip or major osteoporotic fracture for ages 40 and over

Means (arithmetic and back-transformed) and percentile values for the 10-year fracture probability estimates in adults aged 40 and over are shown by detailed age, sex, and race and Hispanic-origin categories for hip fracture in [Table 1](#) and for major osteoporotic fracture in [Table 2](#). Results in the detailed tables for non-Hispanic black, Hispanic, non-Hispanic Asian, and other race groups are not shown by decade because sample sizes were insufficient to provide statistically reliable estimates for a majority of the age groups. The back-transformed mean for the 10-year probability of hip fracture in the United States was 0.5% for adults aged 40 and over and 0.9% for adults aged 50 and over ([Table 1](#)). Geometric means for the 10-year probability of major osteoporotic

fracture were 5.3% for adults aged 40 and over and 7.4% for adults aged 50 and over ([Table 2](#)). Approximately 2.5% of adults aged 40 and over had a 10-year hip fracture probability equal to zero (data not shown).

A comparison of adjusted, back-transformed mean fracture probabilities for adults aged 40 and over by age, sex, and race and Hispanic origin is shown in [Table B](#) for both fracture types. After adjusting for sex and race and Hispanic origin, mean back-transformed hip and major osteoporotic fracture probabilities increased significantly with age. After adjusting for age and race and Hispanic origin, mean back-transformed probability estimates were also significantly higher in women than in men, by 0.1 percentage point for hip fracture and 2 percentage points for major osteoporotic fracture. Finally, mean back-transformed hip and major osteoporotic fracture probabilities differed significantly by race and Hispanic origin after adjusting for age

and sex. The 10-year probability for both fracture types differed significantly between non-Hispanic white persons and the other race and Hispanic-origin groups, by 0.3–0.6 percentage points for hip fracture and 3–4 percentage points for major osteoporotic fracture. The probability of hip fracture was significantly higher in non-Hispanic Asian persons compared with Hispanic persons, but the probability of major osteoporotic fracture did not differ between these two groups.

Prevalence of elevated 10-year probability of hip or major osteoporotic fracture by age, sex, and race and Hispanic origin for ages 50 and over

The prevalence of adults aged 50 and over having a 10-year hip fracture or major osteoporotic fracture probability that exceeds the intervention thresholds defined by NOF guidelines (9) is shown in [Table C](#). This analysis focuses on adults aged 50 and over because NOF criteria were defined for that age range. Overall, approximately 19% of adults aged 50 and over had a hip fracture probability that was 3% or more, and 8% had a major osteoporotic fracture probability that was 20% or more.

After adjusting for age, the proportion with elevated 10-year hip and major osteoporotic fracture probabilities, as defined by NOF criteria (9), was two to seven times higher in women than in men ($p < 0.001$) ([Table C](#)). The unadjusted prevalence of elevated 10-year probability of both fracture types also increased significantly with age ($p < 0.001$). Specifically, the unadjusted prevalence of elevated hip fracture probability increased from 7% among those aged 50–59 to 72% in those aged 80 and over. The unadjusted prevalence of elevated major osteoporotic fracture probability increased from 3% in the youngest age group to 27% in the oldest age group. Finally, age-adjusted 10-year fracture probabilities were significantly higher in non-Hispanic white persons than in other race and Hispanic-origin groups for both fracture types ($p < 0.001$).

Table B. Adjusted mean FRAX-based 10-year probability of hip and major osteoporotic fracture among adults aged 40 and over, by sex, age, and race and Hispanic origin: United States, 2013 and 2014

Sex, age, and race and Hispanic origin	Sample size	Hip fracture probability		Major osteoporotic fracture probability	
		Mean	Standard error	Mean	Standard error
Sex					
Men	1,546	0.45	0.003	4.38	0.06
Women	1,581	0.59	0.011	6.29	0.12
<i>p</i> value .....	...	< 0.001	...	< 0.001	...
Age group (years)					
40–49	897	0.10	0.00004	2.59	0.04
50–59	784	0.38	0.003	5.54	0.15
60–69	788	0.86	0.036	7.77	0.18
70–79	428	*2.41	*1.100	9.57	0.22
80 and over	230	**	**	11.35	0.35
<i>p</i> value, linear trend .....	...	< 0.001	...	< 0.001	...
Race and Hispanic origin					
Non-Hispanic white	1,374	†0.67	0.013	†6.59	0.11
Non-Hispanic black	626	†0.11	0.00005	†2.25	0.05
Hispanic	693	†0.29	0.001	†3.23	0.08
Non-Hispanic Asian	365	†0.42	0.005	†3.35	0.08
<i>p</i> value .....	...	< 0.001	...	< 0.001	...

... Category not applicable.

* Figure does not meet standards of reliability or precision; standard error / estimate is between 30% and 49% or estimate is based on less than 12 degrees of freedom.

** Figure does not meet standards of reliability or precision; standard error / estimate is greater than 50%.

† Significantly different from all other race and Hispanic-origin groups, $p < 0.05$.

‡ Significantly different from all other race and Hispanic-origin groups except non-Hispanic Asian, $p < 0.05$.

§ Significantly different from all other race and Hispanic-origin groups except Hispanic, $p < 0.05$.

NOTES: FRAX-based 10-year fracture probability is an estimate of the likelihood of having a fracture during the next 10 years. It is based on age, sex, race and Hispanic origin, femur neck bone mineral density, body mass index, smoking, alcohol use, glucocorticoid use, personal and parental fracture history, and rheumatoid arthritis. Means for each demographic characteristic have been adjusted for the other demographic characteristics shown in the table.

Table C. Prevalence of elevated FRAX-based 10-year probability of hip or major osteoporotic fracture among adults aged 50 and over, by sex, age, and race and Hispanic origin: United States, 2013 and 2014

Sex, age, and race and Hispanic origin	Sample size	Hip fracture probability 3% or more			Major osteoporotic fracture probability 20% or more		
		Percent	Standard error	Age-adjusted percent	Percent	Standard error	Age-adjusted percent
Total:	2,230	18.9	1.08	22.6	8.3	0.49	9.6
Men	1,111	12.9	1.00	16.6	2.2	0.50	2.3
Women	1,119	24.7	1.99	†27.4	14.1	0.85	†15.5
Age group (years):							
50–59	784	6.7	0.85	...	2.9	0.81	...
60–69	788	11.3	1.60	...	6.4	1.15	...
70–79	428	38.6	3.05	...	16.1	3.38	...
80 and over	230	71.6	2.47	...	27.4	1.89	...
Race and Hispanic origin:							
Non-Hispanic white	1,029	22.8	1.42	25.5	10.6	0.70	11.6
Non-Hispanic black	464	†2.8	1.13	*†4.8	**	**	**
Hispanic	461	5.6	1.19	†10.7	*1.0	0.44	*†1.8
Non-Hispanic Asian	238	11.6	1.95	†16.0	**	**	**

† Significantly different from men, $p < 0.05$.

... Category not applicable.

* Figure does not meet standards of reliability or precision; standard error / estimate is between 30% and 49% or estimate is based on less than 12 degrees of freedom.

† Significantly different from non-Hispanic white, $p < 0.05$.

** Figure does not meet standards of reliability or precision; standard error / estimate is greater than 50%.

NOTES: FRAX-based 10-year fracture probability is an estimate of the likelihood of having a fracture during the next 10 years. It is based on age, sex, race and Hispanic origin, femur neck bone mineral density, body mass index, smoking, alcohol use, glucocorticoid use, personal and parental fracture history, and rheumatoid arthritis.

The femur neck status of adults aged 50 and over with elevated 10-year hip or major osteoporotic fracture probabilities is shown in [Figure 1](#). Between 95% and 97% of adults aged 50 and over with an elevated probability of either fracture type had poor status at the femur neck. Among adults with an elevated hip fracture probability, 67% had low bone mass, and 30% had osteoporosis at the femur neck. Corresponding values for those with elevated major osteoporotic fracture probability were 53% with low bone mass and 42% with osteoporosis at the femur neck.

The agreement in hip and major osteoporotic fracture risk status as defined by the NOF criteria among adults aged 50 and over is shown in [Figure 2](#). Status agreed for 89% of older adults overall: 81% did not have an elevated risk for either fracture type, and 8% had an elevated risk for both fracture types. Those with discordant status were almost exclusively limited to adults with an elevated probability of hip fracture only (11%); less than 1% had an elevated probability of major osteoporotic fracture alone. Approximately 50% of the adults with an elevated hip fracture probability alone had a major osteoporotic fracture probability of 15.0%–19.9% (data not shown).

Discussion

This report provides the first nationally representative estimates of FRAX-based 10-year probability of hip and major osteoporotic fracture for adults aged 40 and over in the United States for survey period 2013–2014. Estimates of the prevalence of elevated fracture probability in adults aged 50 and over, the group for which intervention thresholds have been defined, are also provided. After correcting for the skewed nature of the distribution, the average 10-year probabilities of hip fracture and major osteoporotic fracture among adults aged 40 and over were 0.5% and 5.3%, respectively, compared with 0.9% and 7.4%, respectively, among adults aged 50 and over. In the age group 50 and over, approximately 19% had an elevated 10-year hip fracture probability score, and 8% had an elevated 10-year major osteoporotic fracture probability score when intervention thresholds from NOF were applied (9). Subgroups for which the unadjusted prevalence of an elevated 10-year probability of hip fracture was particularly notable included women (25%), non-Hispanic white persons (23%), and persons aged 70–79 (39%) and 80 and over (72%).

Finding that fracture probability scores vary by age, sex, and race and

Hispanic origin is not surprising, given that fracture incidence is known to vary by these factors. Furthermore, these characteristics are incorporated in the FRAX algorithm, either by inclusion as variables in the model or via development of separate race- and ethnicity-specific models that incorporated racial and ethnic differences in fracture occurrence in the United States. The current report adds to the knowledge base about risk by defining the actual magnitude of the 10-year fracture probability in these demographic groups, which has not been previously described for the U.S. population.

This report also describes the prevalence of the different clinical risk factors (e.g., factors related to lifestyle and health history) that were used in calculating the 10-year fracture probability scores. The majority of middle-aged and older adults (59%) had at least one clinical risk factor for fracture in the survey period 2013–2014, and 23% had two or more risk factors. Three individual clinical risk factors (previous fracture, alcohol use, and current smoking) were fairly common, having been reported by 18%–35% of middle-aged and older adults. In contrast, the other individual clinical risk factors (parental hip fracture, RA, and glucocorticoid use) were reported by 9% or less of these adults.

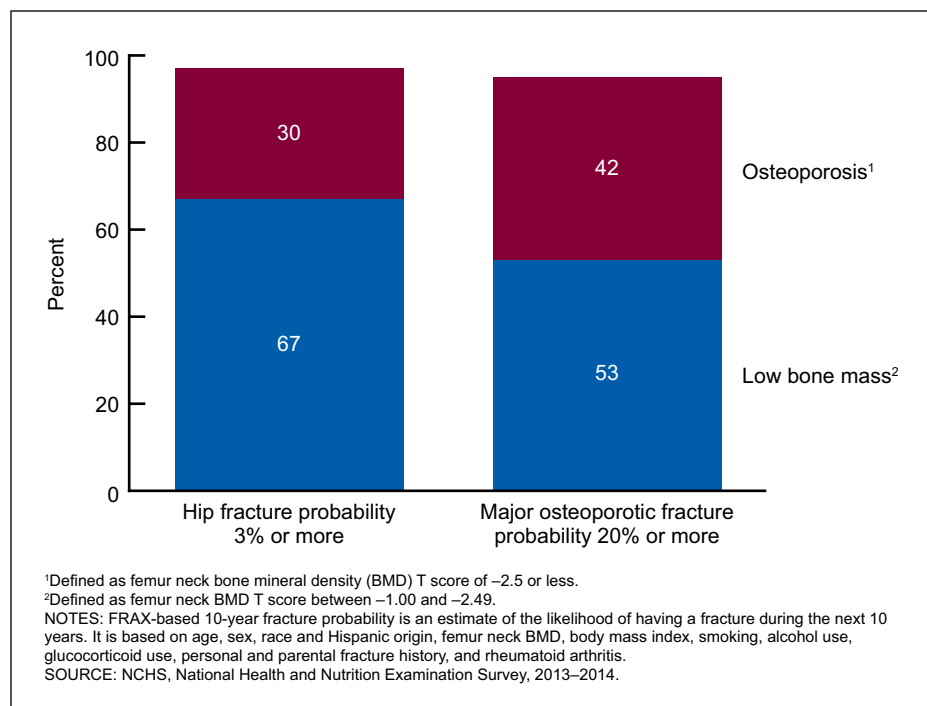


Figure 1. Prevalence of osteoporosis or low bone mass at the femur neck among adults aged 50 and over having elevated FRAX-based 10-year probability of hip or major osteoporotic fracture: United States, 2013 and 2014

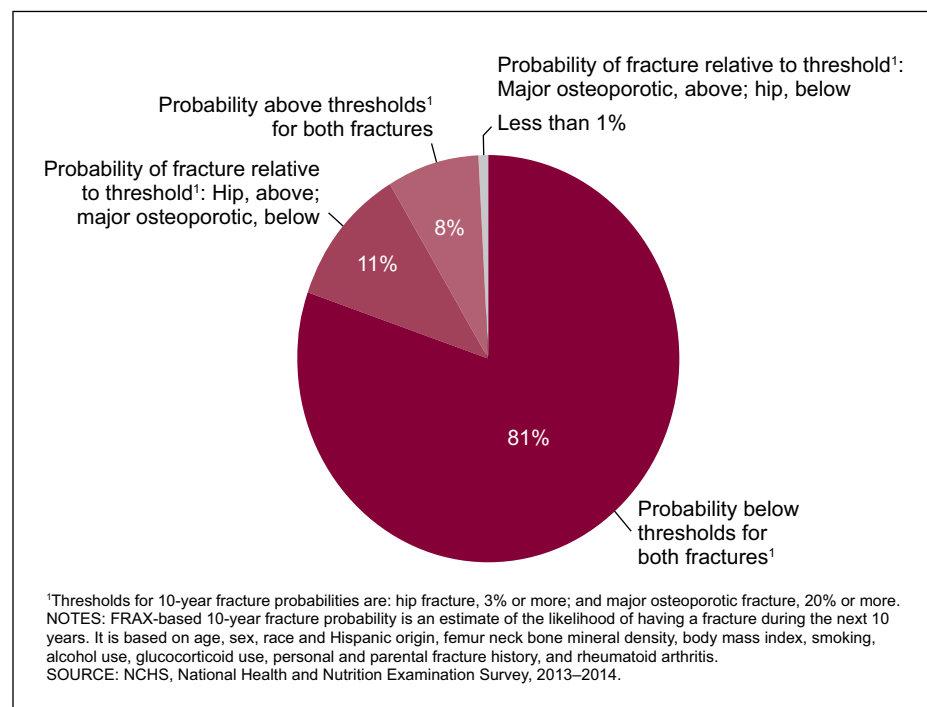


Figure 2. Concordance of hip and major osteoporotic 10-year fracture probability status for adults aged 50 and over: United States, 2013 and 2014

The thresholds to define elevated FRAX scores used in the present study were based on those used in NOF guidelines to identify persons who are candidates for treatment with bone-active

medications (9). Note that the NOF guidelines use elevated FRAX scores in combination with low bone mass to define treatment eligibility, rather than focusing on FRAX scores alone. As a

result, it was of interest in the present study to examine how many adults with elevated FRAX scores also had low bone mass. An estimated 95%–97% of those with an elevated hip or major osteoporotic fracture probability score had either low bone mass at the femur neck (fulfilling the NOF criteria for elevated fracture probability and low bone mass) or osteoporosis at the femur neck (fulfilling a separate criteria used in the NOF guidelines to identify treatment-eligible persons). The remaining 3%–5% with elevated fracture probability scores and normal femur neck status may have met one of the other conditions outlined in the NOF criteria (e.g., poor lumbar spine status or a previous hip or spine fracture), but this was not examined in the present study. It was also of interest to examine agreement in elevated probability of hip compared with major osteoporotic fracture risk as defined by the NOF cutoffs. The vast majority of adults aged 50 and over had similar status (89%), either elevated or not elevated, for both fracture probability estimates. Almost all of the adults with discordant status had an elevated hip fracture probability alone. Further analyses revealed that the majority of these persons also had a major osteoporotic fracture probability score that was within five percentage points of the threshold of 20%, indicating that the discordance was not extreme. However, some of the discordance may reflect the fact that the relationship between FRAX-based estimates of the 10-year probability of hip and major fractures is not straightforward, as noted by Kanis et al. (5). Specifically, Kanis et al. found that although the predicted probability of hip and major osteoporotic fractures were correlated, the magnitude of the predicted probability of a major osteoporotic fracture derived from the hip fracture probability estimate ranged between 5% and 25% (5).

Note that definitions of elevated fracture probability used in osteoporosis guidelines may vary between countries as well as between guidelines within a country (5). Differences between countries may be related to differences in economic circumstances (e.g., reimbursement issues, access to health care, and others), while differences

between guidelines within a country may be related to the guideline objectives. For example, NOF thresholds were derived to serve as treatment thresholds (9), whereas the thresholds recommended by the U.S. Preventive Services Task Force were derived to identify those aged 50–65 who should receive bone density testing (12). The present study used the thresholds recommended in the NOF guideline, since this guideline has been widely adopted within the United States and has also been cited as the basis for thresholds used in other countries (5). The NOF thresholds were based on a cost-effectiveness analysis conducted in the mid-2000s (20). However, concerns about the NOF thresholds have been noted, including the likelihood that many of the assumptions used in the cost-effective analysis are now out-of-date, as well as questions of whether the hip fracture threshold is truly cost-effective (5). The assumption underlying the NOF threshold for major osteoporotic fracture (e.g., that major osteoporotic fracture risk greater than 20% is equivalent to the hip fracture risk greater than 3%) has also been questioned in light of the complicated relationship between fracture probabilities for these two fracture groups (5).

Limitations of the present study include the use of self-reported clinical risk factor information to calculate the 10-year fracture probability scores, because self-reported information can vary in accuracy. For example, a study using data from the Women's Health Initiative found that the accuracy of self-reported fracture information varied depending on the skeletal site: Agreement between fractures identified via medical records compared with self-report was almost 80% for hip fracture and wrist or forearm fractures, but only 51% for spine fracture (22). The accuracy of reporting an RA diagnosis also appears to vary between self-report and medical records. In the present study, the prevalence of self-reported physician's diagnosis of RA among adults aged 40 and over was 4.6%, but estimates of its prevalence among adults aged 18 and over is 0.5%–1% when based on medical records (23,24). Some of the discrepancy for RA may be caused by the difference in the age range considered because the incidence of RA

increases with age (24), but it seems unlikely that this would account for the almost fivefold higher prevalence when based on self-report. On the other hand, use of self-reported data for the clinical risk factors used to calculate the fracture probability scores may correspond more closely to the way that this risk factor information is obtained in many clinical settings. For example, FRAX probability scores generated as part of a DXA examination at an imaging center may rely on self-reported information because the person's medical records are not accessible in that setting.

Other study limitations include possible nonresponse bias in the estimates, because 16% of examined respondents did not have 10-year fracture probability score data. Adjusting the sample weights for missing data by age, sex, and race and Hispanic origin in the analytic sample produced similar results as those based on the publicly available sample weights, which suggests that nonresponse bias in these demographic variables was not likely affecting results. These analyses do not address nonresponse bias due to other factors, however. Finally, institutionalized people, an important high-risk group for fracture, are not included in the NHANES sampling frame by design.

In summary, this report provides the first nationally representative estimates of the absolute probability of suffering a hip or major osteoporotic fracture in the next 10 years among middle-aged and older adults in the United States using the FRAX model. These FRAX-based findings expand the understanding of skeletal health in the United States by providing a more global evaluation of fracture risk than can be obtained from estimates based on BMD alone (4).

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Table 1. FRAX-based 10-year probability of hip fracture among adults aged 40 and over, by sex, race and Hispanic origin, and age: United States, 2013 and 2014

Sex, race and Hispanic origin, and age group (years)	Sample size	Arithmetic mean	Standard error	Back-transformed mean ¹	Percentile								
					5th	10th	15th	25th	50th	75th	85th	90th	95th
Both sexes													
Percent													
All race and Hispanic origin:													
40 and over	3,127	1.43	0.08	0.52	*	0.01	0.03	0.09	0.39	1.41	2.65	3.76	6.05
40 and over, age-adjusted	3,127	1.53	...	0.52	...	...	...	...	...	...	...	...	...
50 and over	2,230	1.97	0.10	0.92	0.02	0.06	0.11	0.24	0.75	2.22	3.56	5.01	7.62
50 and over, age-adjusted	2,230	2.26	...	1.07	...	...	...	...	...	...	...	...	...
40–49	897	0.22	0.02	0.09	†	**0.00	0.00	0.01	0.07	0.21	0.40	0.54	0.87
50–59	784	0.91	0.10	0.38	0.01	0.02	0.04	0.09	0.29	0.77	1.50	1.99	3.56
60–69	788	1.38	0.07	0.88	0.07	0.14	0.23	0.37	0.79	1.65	2.54	3.25	4.70
70–79	428	3.83	0.38	2.53	0.34	0.54	0.71	1.13	2.32	4.47	6.48	8.84	12.34
80 and over	230	5.9	0.28	4.72	1.18	1.67	1.98	2.73	4.34	7.26	8.74	10.82	14.53
Non-Hispanic white:													
40 and over	1,374	1.78	0.11	0.75	**0.01	0.04	0.07	0.16	0.58	1.91	3.32	4.52	7.33
40 and over, age-adjusted	1,374	1.73	...	0.68	...	...	...	...	...	...	...	...	...
50 and over	1,029	2.31	0.14	1.18	0.04	0.11	0.17	0.35	0.99	2.75	4.16	5.73	8.77
50 and over, age-adjusted	1,029	2.53	...	1.30	...	...	...	...	...	...	...	...	...
40–49	345	0.29	0.03	0.14	*	**0.00	**0.01	0.04	0.12	0.31	0.52	0.67	1.03
50–59	337	1.11	0.14	0.50	0.02	0.04	0.07	0.14	0.39	1.00	1.85	2.82	3.80
60–69	278	1.59	0.10	1.08	0.13	0.27	0.32	0.45	0.94	1.85	2.94	3.49	5.02
70–79	235	4.32	0.52	2.99	0.48	0.72	0.91	1.40	2.57	5.20	7.00	9.22	13.95
80 and over	179	**6.20	0.32	**5.05	**1.48	**1.89	**2.17	**3.01	**4.90	**7.43	**8.77	**11.68	**15.12
Non-Hispanic black:													
40 and over	626	0.36	0.04	0.09	†	†	†	**0.01	0.06	0.25	0.55	0.90	1.46
40 and over, age-adjusted	626	0.48	...	0.11	...	...	...	...	...	...	...	...	...
50 and over	464	0.52	0.07	0.20	*	0.01	0.01	0.04	0.12	0.49	0.90	1.20	1.99
50 and over, age-adjusted	464	0.72	...	0.28	...	...	...	...	...	...	...	...	...
Hispanic:													
40 and over	693	0.51	0.04	0.17	†	*	**0.01	0.02	0.11	0.41	0.83	1.21	2.33
40 and over, age-adjusted	693	0.92	...	0.29	...	...	...	...	...	...	...	...	...
50 and over	461	0.86	0.08	0.41	**0.01	**0.03	0.06	0.10	0.32	0.92	1.63	2.20	3.09
50 and over, age-adjusted	461	1.37	...	0.63	...	...	...	...	...	...	...	...	...
Non-Hispanic Asian:													
40 and over	365	0.88	0.11	0.35	*	**0.01	**0.02	0.06	0.25	0.92	1.60	2.23	3.77
40 and over, age-adjusted	365	1.05	...	0.42	...	...	...	...	...	...	...	...	...
50 and over	238	1.35	0.16	0.76	0.05	0.09	0.13	0.24	0.65	1.52	2.53	3.22	4.56
50 and over, age-adjusted	238	1.56	...	0.87	...	...	...	...	...	...	...	...	...
Other races, including multiracial:													
40 and over	69	**1.17	0.27	**0.41	*	*	*	**0.06	**0.28	**1.27	*	**2.65	**5.61
40 and over, age-adjusted	69	**1.98	...	**0.71	...	...	...	...	...	...	...	...	...
50 and over	38	**2.06	0.45	**1.14	*	*	**0.22	*	**1.12	*	**5.32	**5.59	**6.20
50 and over, age-adjusted	38	**2.96	...	**1.60	...	...	...	...	...	...	...	...	...

Table 1. FRAX-based 10-year probability of hip fracture among adults aged 40 and over, by sex, race and Hispanic origin, and age: United States, 2013 and 2014—Con.

Sex, race and Hispanic origin, and age group (years)	Sample size	Arithmetic mean	Standard error	Back-transformed mean ¹	Percentile								
					5th	10th	15th	25th	50th	75th	85th	90th	95th
Men													
All race and Hispanic origin:													
40 and over	1,546	1.01	0.04	0.42	*	0.02	0.04	0.08	0.34	1.11	2.05	2.84	4.33
40 and over, age-adjusted	1,546	1.12	...	0.45	...	...	...	...	...	...	...	...	...
50 and over	1,111	1.36	0.05	0.70	0.03	0.06	0.09	0.17	0.58	1.67	2.76	3.53	5.33
50 and over, age-adjusted	1,111	1.59	...	0.85	...	...	...	...	...	...	...	...	...
40–49	435	0.26	0.04	0.10	†	**0.003	**0.01	0.02	0.10	0.24	0.43	0.55	0.94
50–59	402	0.75	0.07	0.34	*	0.03	0.05	0.09	0.27	0.70	1.37	2.04	3.27
60–69	384	1.1	0.10	0.70	0.06	0.12	0.21	0.31	0.66	1.22	1.78	2.26	3.41
70–79	215	2.64	0.17	1.88	**0.18	0.41	0.50	0.90	1.82	3.42	4.54	5.68	6.90
80 and over	110	3.67	0.21	3.24	1.13	1.44	1.65	1.97	3.15	5.14	6.04	6.24	7.26
Non-Hispanic white:													
40 and over	660	1.24	0.05	0.60	**0.02	0.04	0.07	0.14	0.49	1.53	2.52	3.41	5.18
40 and over, age-adjusted	660	1.27	...	0.59	...	...	...	...	...	...	...	...	...
50 and over	495	1.58	0.06	0.90	0.04	0.09	0.15	0.29	0.77	2.10	3.09	4.01	5.88
50 and over, age-adjusted	495	1.78	...	1.03	...	...	...	...	...	...	...	...	...
40–49	165	0.34	0.06	0.16	*	*	**0.028	0.05	0.14	0.33	0.53	0.69	1.19
50–59	175	0.91	0.07	0.45	**0.03	0.05	0.07	0.13	0.35	1.00	1.73	2.38	3.72
60–69	123	1.27	0.12	0.86	*	0.25	0.29	0.42	0.76	1.38	2.04	2.42	3.48
70–79	111	**2.89	0.21	**2.19	**0.37	**0.49	**0.71	**1.15	**2.29	**3.58	**4.77	**5.87	**7.36
80 and over	86	**3.87	0.23	**3.45	**1.21	**1.54	**1.71	**2.11	**3.33	**5.23	**6.08	**6.32	**7.34
Non-Hispanic black:													
40 and over	329	0.28	0.05	0.08	†	†	†	0.01	0.07	0.24	0.47	0.58	1.02
40 and over, age-adjusted	329	0.36	...	0.10	...	...	...	...	...	...	...	...	...
50 and over	250	0.38	0.08	0.15	†	**0.00	**0.01	0.04	0.11	0.35	0.55	0.81	1.36
50 and over, age-adjusted	250	0.51	...	0.22	...	...	...	...	...	...	...	...	...
Hispanic:													
40 and over	344	0.41	0.04	0.15	†	0.01	0.01	0.03	0.11	0.34	0.58	0.91	1.33
40 and over, age-adjusted	344	0.78	...	0.26	...	...	...	...	...	...	...	...	...
50 and over	233	0.67	0.08	0.30	**0.01	**0.02	0.05	0.08	0.24	0.62	1.04	1.25	2.74
50 and over, age-adjusted	233	1.16	...	0.51	...	...	...	...	...	...	...	...	...
Non-Hispanic Asian:													
40 and over	181	0.55	0.07	0.28	*	0.02	0.03	0.07	0.21	0.66	1.12	1.53	2.20
40 and over, age-adjusted	181	0.67	...	0.33	...	...	...	...	...	...	...	...	...
50 and over	116	0.81	0.09	0.54	0.06	0.09	0.12	0.17	0.51	1.04	1.52	1.83	2.78
50 and over, age-adjusted	116	0.94	...	0.62	...	...	...	...	...	...	...	...	...
Other races, including multiracial:													
40 and over	32	**1.02	0.34	**0.34	†	*	*	*	*	*	*	**2.90	†
40 and over, age-adjusted	32	**0.97	...	**0.39	...	...	...	...	...	...	...	...	...
50 and over	17	**1.87	0.62	**1.01	†	†	†	†	*	*	**5.40	†	†
50 and over, age-adjusted	17	**1.42	...	**0.78	...	...	...	...	...	...	...	...	...

Table 1. FRAX-based 10-year probability of hip fracture among adults aged 40 and over, by sex, race and Hispanic origin, and age: United States, 2013 and 2014—Con.

Sex, race and Hispanic origin, and age group (years)	Sample size	Arithmetic mean	Standard error	Back-transformed mean ¹	Percentile								
					5th	10th	15th	25th	50th	75th	85th	90th	95th
Women													
Percent													
All race and Hispanic origin:													
40 and over	1,581	1.84	0.15	0.62	*	0.01	0.02	0.09	0.46	1.78	3.32	4.94	8.66
40 and over, age-adjusted	1,581	1.87	...	0.58	...	...	...	...	...	...	...	...	...
50 and over	1,119	2.55	0.18	1.18	0.02	0.08	0.13	0.3	0.97	2.96	4.69	6.57	9.78
50 and over, age-adjusted	1,119	2.81	...	0.13	...	...	...	...	...	...	...	...	...
40–49	462	0.19	0.02	0.07	†	†	**0.01	0.01	0.06	0.19	0.35	0.53	0.78
50–59	382	1.1	0.21	0.43	**0.01	0.02	0.04	0.11	0.34	0.92	1.61	1.94	**3.66
60–69	404	1.65	0.12	1.07	0.10	0.18	0.26	0.42	0.98	1.99	3.08	4.08	5.39
70–79	213	4.92	0.63	3.26	0.58	0.73	0.89	1.37	2.63	5.84	8.87	11.39	17.63
80 and over	120	7.34	0.50	5.90	1.42	2.16	2.77	3.38	5.58	8.69	11.29	13.63	16.34
Non-Hispanic white:													
40 and over	714	2.31	0.21	0.92	**0.01	0.03	0.07	0.17	0.72	2.57	4.28	5.99	9.39
40 and over, age-adjusted	714	2.13	...	0.76	...	...	...	...	...	...	...	...	...
50 and over	534	3.02	0.24	1.52	**0.04	0.14	0.23	0.42	1.25	3.48	5.50	7.60	12.27
50 and over, age-adjusted	534	3.17	...	1.58	...	...	...	...	...	...	...	...	...
40–49	180	0.26	0.03	0.13	†	*	**0.01	**0.03	0.12	0.28	0.53	0.67	1.03
50–59	162	1.35	0.31	0.56	0.02	*	**0.08	0.15	0.43	1.07	1.91	3.14	*
60–69	155	1.9	0.17	1.32	0.18	0.31	0.38	0.63	1.20	2.58	3.39	4.57	5.39
70–79	124	5.62	0.82	3.88	0.66	0.87	1.14	1.72	3.04	6.82	9.28	12.49	18.86
80 and over	93	**7.73	0.60	**6.35	**1.95	**2.72	**3.05	**3.71	**5.96	**8.73	**12.36	**13.99	**16.40
Non-Hispanic black:													
40 and over	297	0.44	0.08	0.10	†	†	†	0.01	0.06	0.29	0.71	1.13	1.88
40 and over, age-adjusted	297	0.56	...	0.12	...	...	...	...	...	...	...	...	...
50 and over	214	0.65	0.12	0.24	0.01	0.01	0.02	0.04	0.15	0.63	1.15	1.45	2.33
50 and over, age-adjusted	214	0.86	...	0.33	...	...	...	...	...	...	...	...	...
Hispanic:													
40 and over	349	0.62	0.06	0.19	†	*	*	**0.02	0.13	0.58	1.05	1.77	2.68
40 and over, age-adjusted	349	1.04	...	0.32	...	...	...	...	...	...	...	...	...
50 and over	228	1.05	0.12	0.54	**0.02	**0.04	0.08	0.13	0.44	1.30	2.03	2.35	3.43
50 and over, age-adjusted	228	1.55	...	0.76	...	...	...	...	...	...	...	...	...
Non-Hispanic Asian:													
40 and over	184	1.18	0.20	0.44	**0.01	0.02	**0.02	0.06	0.30	1.27	2.02	3.26	4.71
40 and over, age-adjusted	184	1.35	...	0.49	...	...	...	...	...	...	...	...	...
50 and over	122	**1.79	0.27	**0.98	**0.04	**0.10	**0.15	**0.30	**0.83	**1.98	**3.27	**4.24	**5.83
50 and over, age-adjusted	122	**2.04	...	**1.11	...	...	...	...	...	...	...	...	...
Other races, including multiracial:													
40 and over	37	**1.33	0.42	**0.49	*	*	**0.05	**0.09	*	**1.56	**1.59	*	**5.02
40 and over, age-adjusted	37	**1.86	...	**0.73	...	...	...	...	...	...	...	...	...
50 and over	21	**2.24	0.67	**1.27	†	*	*	*	**1.24	**1.59	*	**4.49	†
50 and over, age-adjusted	21	**2.79	...	**1.62	...	...	...	...	...	...	...	...	...

* Figure does not meet standards of reliability or precision; relative standard error (standard error / estimate) is 50% or more.

... Category not applicable.

† Standard error not calculated by SUDAAN.

** Figure does not meet standards of reliability or precision; relative standard error (standard error / estimate) is 30%–49% or estimate is based on less than 12 degrees of freedom.

¹Calculated as (transformed mean)⁴.

NOTES: FRAX-based 10-year fracture probability is an estimate of the likelihood of having a fracture during the next 10 years. It is based on age, sex, race and Hispanic origin, femur neck bone mineral density, body mass index, smoking, alcohol use, glucocorticoid use, personal and parental fracture history, and rheumatoid arthritis.

Table 2. FRAX-based 10-year probability of major osteoporotic fracture among adults aged 40 and over, by sex, race and Hispanic origin, and age: United States, 2013 and 2014

Sex, race and Hispanic origin, and age group (years)	Sample size	Arithmetic mean	Standard error	Geometric Mean	Percentile								
					5th	10th	15th	25th	50th	75th	85th	90th	95th
Both sexes					Percent								
All race and Hispanic origin:													
40 and over	3,127	7.45	0.21	5.26	1.22	1.76	2.08	2.71	5.31	9.70	13.28	15.71	20.80
40 and over, age-adjusted	3,127	7.40	...	5.09	...	...	...	...	...	...	...	...	...
50 and over	2,230	9.47	0.21	7.41	2.21	2.96	3.59	4.49	7.36	12.51	15.45	18.51	23.87
50 and over, age-adjusted	2,230	9.92	...	7.72	...	...	...	...	...	...	...	...	...
40–49	897	2.87	0.09	2.41	0.93	1.06	1.19	1.68	2.35	3.54	4.42	5.19	6.32
50–59	784	6.97	0.32	5.53	1.84	2.33	2.90	3.64	5.36	8.28	11.70	12.95	17.04
60–69	788	9.49	0.30	7.95	2.61	3.52	4.20	5.30	8.14	12.77	15.19	17.28	21.07
70–79	428	12.5	0.58	10.17	3.01	4.09	5.42	6.58	10.36	15.80	20.24	23.41	27.65
80 and over	230	16.1	0.52	13.45	5.02	5.74	6.39	9.01	13.96	20.63	25.47	28.50	34.79
Non-Hispanic white:													
40 and over	1,374	8.99	0.23	6.94	2.19	2.57	3.11	4.11	6.82	11.96	15.15	17.81	22.97
40 and over, age-adjusted	1,374	8.49	...	6.38	...	...	...	...	...	...	...	...	...
50 and over	1,029	10.91	0.22	9.09	3.74	4.23	4.66	5.78	8.56	13.80	17.23	20.43	24.66
50 and over, age-adjusted	1,029	11.20	...	9.28	...	...	...	...	...	...	...	...	...
40–49	345	3.62	0.08	3.25	1.80	1.92	2.09	2.26	2.98	4.20	5.19	5.96	7.65
50–59	337	8.19	0.40	6.90	3.30	3.73	4.05	4.45	6.27	9.98	12.36	13.95	17.91
60–69	278	10.97	0.31	9.77	4.55	5.16	5.62	7.18	9.11	13.99	16.58	18.71	21.91
70–79	235	13.99	0.75	11.91	4.46	5.79	6.27	8.04	11.70	17.30	22.19	24.4	28.40
80 and over	179	*16.86	0.55	*14.39	*5.33	*6.32	*7.12	*9.73	*14.62	*22.15	*26.47	*30.11	*36.18
Non-Hispanic black:													
40 and over	626	2.71	0.11	2.13	0.80	0.90	1.03	1.31	2.01	3.11	4.24	5.46	6.74
40 and over, age-adjusted	626	2.94	...	2.22	...	...	...	...	...	...	...	...	...
50 and over	464	3.44	0.15	2.87	1.34	1.53	1.66	1.86	2.61	3.96	5.51	6.30	7.64
50 and over, age-adjusted	464	3.86	...	3.12	...	...	...	...	...	...	...	...	...
Hispanic:													
40 and over	693	3.52	0.11	2.66	1.00	1.07	1.15	1.50	2.45	4.24	5.81	7.52	9.59
40 and over, age-adjusted	693	4.52	...	3.23	...	...	...	...	...	...	...	...	...
50 and over	461	5.11	0.16	4.23	1.97	2.14	2.28	2.64	3.89	6.27	7.91	9.20	12.02
50 and over, age-adjusted	461	6.08	...	4.84	...	...	...	...	...	...	...	...	...
Non-Hispanic Asian:													
40 and over	365	4.32	0.26	3.11	1.04	1.15	1.27	1.60	2.97	5.36	6.98	8.39	12.12
40 and over, age-adjusted	365	4.68	...	3.31	...	...	...	...	...	...	...	...	...
50 and over	238	6.03	0.32	4.93	2.12	2.42	2.61	3.12	4.47	6.94	9.10	11.51	15.26
50 and over, age-adjusted	238	6.41	...	5.16	...	...	...	...	...	...	...	...	...
Other races, including multiracial:													
40 and over	69	*6.63	0.79	*4.70	*1.44	*1.74	*1.77	*2.13	*4.18	*9.31	*12.52	*14.60	*15.47
40 and over, age-adjusted	69	*8.83	...	*6.06	...	...	...	...	...	...	...	...	...
50 and over	38	*10.23	1.01	*8.77	*3.54	*3.92	*4.13	*6.13	*9.04	*12.86	*14.78	*15.28	*17.33
50 and over, age-adjusted	38	*12.18	...	*10.09	...	...	...	...	...	...	...	...	...

Table 2. FRAX-based 10-year probability of major osteoporotic fracture among adults aged 40 and over, by sex, race and Hispanic origin, and age: United States, 2013 and 2014—Con.

Sex, race and Hispanic origin, and age group (years)	Sample size	Arithmetic mean	Standard error	Geometric Mean	Percentile								
					5th	10th	15th	25th	50th	75th	85th	90th	95th
Men													
Percent													
All race and Hispanic origin:													
40 and over	1,546	5.57	0.16	4.31	1.18	1.66	1.93	2.52	4.41	7.41	9.65	11.14	13.55
40 and over, age-adjusted	1,546	5.55	...	4.25	...	...	...	...	...	...	...	...	...
50 and over	1,111	6.85	0.17	5.71	1.86	2.46	2.99	3.93	5.72	8.73	11.09	12.52	15.02
50 and over, age-adjusted	1,111	7.10	...	5.93	...	...	...	...	...	...	...	...	...
40–49	435	2.76	0.14	2.33	0.89	1.04	1.18	1.67	2.32	3.34	4.19	4.88	5.76
50–59	402	5.69	0.23	4.70	1.64	2.06	2.47	3.25	4.43	6.83	8.84	10.86	12.96
60–69	384	7.23	0.31	6.20	2.21	2.72	3.37	4.48	6.35	8.94	10.89	12.02	14.15
70–79	215	8.41	0.38	7.15	2.31	3.11	3.72	5.25	7.40	11.01	13.40	14.84	18.21
80 and over	110	9.23	0.36	8.38	4.34	4.79	5.23	5.86	8.36	11.53	13.92	14.65	16.08
Non-Hispanic white:													
40 and over	660	6.68	0.14	5.61	2.09	2.46	2.95	3.75	5.49	8.53	10.67	12.27	14.66
40 and over, age-adjusted	660	6.41	...	5.30	...	...	...	...	...	...	...	...	...
50 and over	495	7.89	0.14	6.99	3.33	3.93	4.14	4.67	6.82	9.74	11.70	13.30	15.67
50 and over, age-adjusted	495	8.05	...	7.14	...	...	...	...	...	...	...	...	...
40–49	165	3.45	0.17	3.11	1.77	1.86	2.00	2.23	2.76	4.14	4.88	5.34	†
50–59	175	6.68	0.22	5.86	3.05	3.35	3.66	4.13	5.14	8.14	10.48	12.06	14.16
60–69	123	8.40	0.36	7.66	4.06	4.52	4.77	5.47	8.07	9.76	11.33	12.89	15.06
70–79	111	*9.29	0.37	*8.33	*3.63	*4.45	*5.27	*6.09	*8.16	*11.26	*13.98	*15.29	*19.51
80 and over	86	*9.71	0.39	*8.97	*4.82	*5.24	*5.45	*6.35	*9.11	*11.93	*14.48	*14.68	*16.35
Non-Hispanic black:													
40 and over	329	2.07	0.07	1.77	0.79	0.86	0.95	1.25	1.72	2.47	2.95	3.34	4.06
40 and over, age-adjusted	329	2.15	...	1.82	...	...	...	...	...	...	...	...	...
50 and over	250	2.46	0.10	2.19	1.25	1.33	1.44	1.60	2.01	2.85	3.26	3.69	4.94
50 and over, age-adjusted	250	2.62	...	2.33	...	...	...	...	...	...	...	...	...
Hispanic:													
40 and over	344	2.78	0.11	2.29	0.94	1.04	1.13	1.43	2.28	3.21	4.27	5.13	6.30
40 and over, age-adjusted	344	3.39	...	2.70	...	...	...	...	...	...	...	...	...
50 and over	233	3.76	0.12	3.31	1.67	2.00	2.10	2.34	2.99	4.59	5.51	6.01	7.56
50 and over, age-adjusted	233	4.36	...	3.73	...	...	...	...	...	...	...	...	...
Non-Hispanic Asian:													
40 and over	181	3.04	0.19	2.48	1.00	1.10	1.23	1.47	2.43	3.97	4.61	5.75	7.02
40 and over, age-adjusted	181	3.27	...	2.66	...	...	...	...	...	...	...	...	...
50 and over	116	4.09	0.25	3.66	1.88	2.14	2.32	2.60	3.53	4.59	5.86	6.90	8.29
50 and over, age-adjusted	116	4.24	...	3.77	...	...	...	...	...	...	...	...	...
Other races, including multiracial:													
40 and over	32	*4.95	0.64	*3.85	†	*1.74	*1.75	*2.05	*3.44	*6.68	*8.06	*10.60	*11.47
40 and over, age-adjusted	32	*5.12	...	*4.12	...	...	...	...	...	...	...	...	...
50 and over	17	*7.63	0.67	*6.83	†	*3.71	*3.80	*4.01	*6.75	*9.68	*11.36	*11.48	*12.64
50 and over, age-adjusted	17	*6.76	...	*5.97	...	...	...	...	...	...	...	...	...

Table 2. FRAX-based 10-year probability of major osteoporotic fracture among adults aged 40 and over, by sex, race and Hispanic origin, and age: United States, 2013 and 2014—Con.

Sex, race and Hispanic origin, and age group (years)	Sample size	Arithmetic mean	Standard error	Geometric Mean	Percentile								
					5th	10th	15th	25th	50th	75th	85th	90th	95th
Women					Percent								
All race and Hispanic origin:													
40 and over	1,581	9.29	0.32	6.38	1.27	1.88	2.24	3.12	6.74	13.05	16.60	19.75	24.78
40 and over, age-adjusted	1,581	9.01	...	6.00	...	...	...	...	...	...	...	...	...
50 and over	1,119	11.97	0.30	9.52	2.79	3.75	4.55	6.02	9.64	15.58	19.43	22.94	27.65
50 and over, age-adjusted	1,119	12.35	...	9.77	...	...	...	...	...	...	...	...	...
40–49	462	2.99	0.11	2.50	0.99	1.10	1.22	1.72	2.44	3.76	4.55	5.89	7.27
50–59	382	8.39	0.52	6.62	2.13	2.72	3.30	4.27	6.33	10.31	12.98	15.27	19.08
60–69	404	11.57	0.48	9.97	3.55	4.63	5.72	7.07	9.78	15.24	17.77	20.30	22.12
70–79	213	16.20	0.92	13.97	5.66	6.92	8.00	9.62	14.56	20.38	24.41	27.65	†
80 and over	120	20.54	0.84	18.23	6.55	10.24	12.23	13.39	18.06	25.19	30.09	33.63	39.41
Non-Hispanic white:													
40 and over	714	11.27	0.40	8.55	2.23	2.68	3.52	4.91	8.70	15.24	19.15	22.71	27.28
40 and over, age-adjusted	714	10.35	...	7.57	...	...	...	...	...	...	...	...	...
50 and over	534	13.84	0.38	11.74	4.54	5.60	6.18	7.64	12.20	17.29	21.58	24.42	29.95
50 and over, age-adjusted	534	13.99	...	11.80	...	...	...	...	...	...	...	...	...
40–49	180	3.81	0.16	3.41	1.85	2.06	2.17	2.40	3.08	4.35	5.93	6.27	8.08
50–59	162	9.88	0.72	8.28	3.89	4.40	4.76	5.58	7.31	12.05	14.19	17.22	†
60–69	155	13.40	0.46	12.29	6.77	7.25	7.63	8.43	12.9	16.58	19.08	21.32	22.85
70–79	124	18.25	1.14	16.45	8.08	9.53	9.97	11.73	15.79	22.8	26.89	28.30	†
80 and over	93	*21.53	0.99	*19.57	*9.96	*12.23	*12.99	*14.32	*19.24	*26.47	*30.49	*34.03	*39.41
Non-Hispanic black:													
40 and over	297	3.30	0.18	2.52	0.81	0.98	1.08	1.50	2.44	4.10	5.73	6.46	7.69
40 and over, age-adjusted	297	3.56	...	2.62	...	...	...	...	...	...	...	...	...
50 and over	214	4.36	0.28	3.70	1.71	1.93	2.05	2.38	3.47	5.55	6.48	6.94	9.20
50 and over, age-adjusted	214	4.80	...	3.98	...	...	...	...	...	...	...	...	...
Hispanic:													
40 and over	349	4.28	0.16	3.08	1.04	1.14	1.21	1.61	2.80	5.40	7.81	8.59	11.91
40 and over, age-adjusted	349	5.46	...	3.79	...	...	...	...	...	...	...	...	...
50 and over	228	6.46	0.28	5.40	2.20	2.60	2.84	3.34	5.11	8.03	10.07	11.68	15.67
50 and over, age-adjusted	228	7.50	...	6.07	...	...	...	...	...	...	...	...	...
Non-Hispanic Asian:													
40 and over	184	5.47	0.40	3.81	1.09	1.19	1.39	1.74	3.83	6.90	9.20	11.88	15.97
40 and over, age-adjusted	184	5.83	...	3.96	...	...	...	...	...	...	...	...	...
50 and over	122	*7.63	0.45	*6.31	*2.52	*3.05	*3.17	*3.94	*6.13	*8.77	*11.90	*14.96	*17.75
50 and over, age-adjusted	122	*8.14	...	*6.64	...	...	...	...	...	...	...	...	...
Other races, including multiracial:													
40 and over	37	*8.45	1.14	*5.84	*1.10	*1.64	*1.87	*2.32	*7.16	*12.63	*14.62	*15.26	*17.41
40 and over, age-adjusted	37	*9.63	...	*6.75	...	...	...	...	...	...	...	...	...
50 and over	21	*12.61	1.32	*11.04	†	*4.76	*5.24	*7.87	*12.14	*14.82	*15.93	*17.15	†
50 and over, age-adjusted	21	*13.23	...	*11.47	...	...	...	...	...	...	...	...	...

... Category not applicable.

* Figure does not meet standards of reliability or precision; relative standard error (standard error / estimate) is 30%–49% or estimate is based on less than 12 degrees of freedom.

† Standard error not calculated by SUDAAN.

NOTES: FRAX-based 10-year fracture probability is an estimate of the likelihood of having a fracture during the next 10 years. It is based on age, sex, race and Hispanic origin, femur neck bone mineral density, body mass index, smoking, alcohol use, glucocorticoid use, personal and parental fracture history, and rheumatoid arthritis.

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National Health Statistics Reports ■ Number 103 ■ March 28, 2017

Suggested citation

Looker AC, Sarafrazi Isfahani N, Fan B, Shepherd JA. FRAX-based estimates of 10-year probability of hip and major osteoporotic fracture among adults aged 40 and over: United States, 2013 and 2014. National health statistics reports; no 103. Hyattsville, MD: National Center for Health Statistics. 2017.

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DHHS Publication No. 2017-1250 • CS274284