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Trends in osteoporosis and low bone mass in older US adults, 2005–2006 through 2013–2014

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Introduction

National data on trends in skeletal status of older adults in the US suggest improvements may have occurred between the mid-1980's and mid-to-late 2000's. For example, data from the National Health and Nutrition Examination Survey (NHANES) showed a decline in the prevalence of femoral neck osteoporosis between 1988–1994 and 2005–2006 (1), and data from Medicare and the National Inpatient Survey indicated a decline in hip fracture incidence between 1985 and 2012, at least in some race/ethnic groups.

Whether these trends are continuing in the present decade is not clear, however. The present study uses bone mineral density (BMD) of the proximal femur and lumbar spine of adults age 50 years and older from four NHANES survey cycles (2005–2006, 2007–2008, 2009–2010 and 2013–2014) to examine trends in osteoporosis and low bone mass based on BMD collected with fan-beam dual-energy x-ray absorptiometry (DXA) densitometers in NHANES since 2005. In addition, NHANES began oversampling non-Hispanic Asians after 2010 for the first time since its inception (2). As a result, the present study also used BMD data from NHANES 2013–14 to provide the first nationally representative estimates of osteoporosis and low bone mass among non-Hispanic Asians, as well as providing updated estimates for non-Hispanic whites, non-Hispanic blacks, and Hispanics.

Methods

Sample

The present study used data collected in the NHANES, which is conducted by the National Center for Health Statistics (NCHS), Centers for Disease Control and Prevention, to assess the health and nutritional status of a representative sample of the non-institutionalized, civilian US population. The present study examines data from four NHANES survey cycles

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covering the periods 2005–2010 and 2013–2014 because these are the survey cycles completed to date in which BMD of the proximal femur and lumbar spine have been measured with fan-beam DXA[1]. NHANES collects data via household interviews and direct standardized physical examinations conducted in specially equipped mobile examination centers (3). All procedures in the NHANES survey cycles used in this study were approved by the NCHS Research Ethics Review Board, and written informed consent was obtained from all subjects. The overall unweighted examination response rate for adults age 50 years and older in the four NHANES survey cycles were 67.1% in 2005–2006 and 2007–2008, 67.2% in 2009–2010, and 59.8% in 2013–2014

Estimates from NHANES 2013–2014 by race and Hispanic origin are presented separately for non-Hispanic whites, non-Hispanic blacks, Hispanics (including Mexican Americans), and non-Hispanic Asians because NHANES 2013–2014 provides reliable estimates for these groups. Race and ethnicity were self-reported by the participants.

The analytic sample used in the present study consisted of 7954 adults ages 50 years and older with valid data for femur neck BMD (FNBMD) and lumbar spine BMD (LSBMD) for at least two lumbar vertebrae, as recommended by ISCD for calculation of lumbar spine T-scores (4). The analytic sample consisted of 1526 respondents from NHANES 2005–2006, 2229 respondents from NHANES 2007–2008, 2198 respondents from NHANES 2009–2010, and 2001 respondents from NHANES 2013–2014.

Bone density

Proximal femur and posterior-anterior lumbar spine scans were obtained with Hologic QDR 4500A fan-beam densitometers in NHANES 2005–2010 and with Hologic Discovery® A densitometers in NHANES 2013–2014 (Hologic Inc., Marlborough MA). Details of the dual-energy x-ray absorptiometry (DXA) examination protocol have been published elsewhere (5). Scanning was done in the fast array mode. Rigorous quality control (QC) programs were employed, to monitor DXA scanners. All QC and respondent scans were analyzed at a central site (Department of Radiology of the University of California, San Francisco), using standard radiologic techniques and study-specific protocols developed for the NHANES (5). All respondent scans were also reviewed by an expert at the central site. Survey respondents were not eligible for DXA scans if they were pregnant, self-reported an imaging procedure using contrast material in the previous seven days, or weighed more than the DXA table weight limit (> 300 pounds in 2005–2010, >450 pounds in 2013–2014).

Spine scans obtained in NHANES 2005–2010 were analyzed using Apex version 3.0 software, while femur scans were analyzed using Discovery 12.4 software. APEX™ version 4.0 was used to analyze femur and spine scans in NHANES 2013–2014. Differences in DXA scan results for the same individuals have been noted previously when different DXA scan analysis software versions were used, so a study using a subsample of 600 adults from NHANES 2005–2010 was performed to compare femur results analyzed by the two software versions; study details and results are described in Supplementary Appendix 1. Results

[1]Data from NHANES III (1988–1994) were not included in the present study because proximal femur BMD was measured with pencil-beam DXA.

showed differences in mean BMD at four of the five regions of interest (ROI) (Supplementary Table 1). The exception occurred at the femur neck. However, software version had little effect on prevalence of low values at the four femur ROI that were examined (Supplementary Table 2), likely due to the fact that software differences were either small overall or were minimal in the lower end of the BMD distributions (Supplementary Figures 1–3).

Skeletal status of adults age 50 years and older was categorized using criteria recommended by the World Health Organization (WHO) (6). T-scores were calculated as: ($BMD_{respondent}$ − mean $BMD_{reference\ group}$)/Standard $deviation_{reference\ group}$. Low bone mass was defined as a T-score between −1.0 and −2.5, while osteoporosis was defined as a T-score <= −2.5. As recommended by the International Society for Clinical Densitometry (ISCD), the reference group for calculation of T-scores at the lumbar spine consisted of 30-year old white females from the DXA manufacturer reference database, while the reference group for calculation of these scores for the femur neck consisted of 20–29 non-Hispanic white females from NHANES III (7). Prevalence of osteoporosis and low bone mass were calculated for the femur neck only, lumbar spine only, and for either the femur neck or lumbar spine. The total femur ROI is also used clinically to define osteoporosis (4), but it was not included in the present study because previous analyses revealed that prevalence estimates based on either femur neck, lumbar spine or total femur differed by less than 1 percentage point from those based on either femur neck or lumbar spine only (8).

Other variables

Trends in osteoporosis or low bone mass by survey period were assessed before and after controlling for changes in selected bone-related variables that might have contributed to changes in bone density over time. The following bone-related variables were selected on the basis of being available for all four survey cycles at the time of the study, and also being measured in a comparable manner in all periods:

Body mass index: calculated as body weight (kilograms) divided by height (meters squared). Body weight was measured using an electronic load cell scale, and standing height was measured with a fixed stadiometer.

Cigarette smoking: smokers were defined as respondents who self-reported that they currently or formerly smoked.

Milk use: Milk users were defined as respondents who reported drinking milk alone or on cereal one or more times per week during the past 30 days.

Osteoporosis diagnosis: Respondents who self-reported that their doctor had told them they had osteoporosis were defined as having an osteoporosis diagnosis.

Statistical analyses

Analyses were conducted with PC-SAS (Version 9.3, SAS Institute, Cary NC) and SUDAAN (Version 11.0.1, Research Triangle Institute, NC). All analyses used the

examination sample weights and accounted for the complex survey design when calculating statistical tests. Prevalence estimates for NHANES 2013–2014 by race/Hispanic origin were age-adjusted to the 2000 Census using the direct method. Tests of statistical significance were performed using t-tests or chi-square analyses (for unadjusted results) and linear or logistic regression (for multivariate adjusted results). Linear and quadratic trends across survey periods by sex were tested by including single degree-of-freedom contrast terms in logistic regression models in which survey period was treated as a categorical variable. When quadratic or linear trends were statistically significant, pairwise comparison of means and prevalence estimates between individual survey periods were performed because there were too few survey cycles to permit use of joinpoint regression models to assess the shape of the trend.

A secondary analysis was performed to assess the impact of the addition of the non-Hispanic Asian oversample to NHANES 2013–2014 on observed trends in skeletal status between 2005 and 2014. Specifically, trends in the prevalence of osteoporosis and low bone mass by survey period were re-examined after limiting the analytic sample to non-Hispanic whites only. Results and conclusions were similar to those observed without restricting the sample to non-Hispanic whites, so results for trends are shown for the full analytic sample. Another secondary analysis was performed to assess the impact of the change in software used to process femur scans between NHANES 2005–2010 (Discovery 12.4 software) and 2013–2014 (Apex 4.0 software). Prediction equations derived from the NHANES 2005–2010 Hip Re-analysis Study (Supplementary Table 3) were used to calculate predicted “Apex 4.0” femur neck BMD values for NHANES 2005–2010. The predicted femur neck BMD values for NHANES 2005–2010 were then used to re-examine linear and quadratic trends in femur neck osteoporosis and low bone mass between all four survey periods. Conclusions regarding trends based on predicted Apex 4.0 femur neck BMD values for NHANES 2005–2010 were the same as when based on femur neck BMD values produced by the Discovery software in NHANES 2005–2010.

Missing Data

The analytic sample was derived from the 10,695 examined adults age 50 years and older in NHANES 2005–2010 and 2013–2014. Of these, 2741 (23.5%) were excluded because they lacked valid proximal femur or lumbar spine BMD data. The final main analytic sample consisted of 7954 respondents.

Because 24% of the examined sample of adults age 50 years and older from the survey periods used in the study had been excluded from the main analytic sample, nonresponse bias analyses were conducted. The proportion of excluded respondents did not differ by survey period (p=0.10), being approximately 21–22% in NHANES 2005–06 and 2007–08, and 25% in NHANES 2009–2010 and NHANES 2013–14. In all survey periods, excluded respondents were more likely to be female, older, black, shorter, 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 non-response using the PROC WTADJUST procedure in SUDAAN. We used this model-based calibration procedure to reweight the data by computing nonresponse

and post-stratification weight adjustments by age, sex, and race/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, so only the latter results are shown.

Results

The prevalence of osteoporosis and low bone mass at the femur neck, lumbar spine, and either the femur neck or lumbar spine among older adults from NHANES 2013–2014 is shown in Table 1. Overall, the prevalence of osteoporosis ranged from 6–11%, while the prevalence of low bone mass ranged from 28–45%, depending on the skeletal variable considered. The prevalence of both conditions were significantly higher in women (10–17% with osteoporosis; 36–53% with low bone mass) than in men (3–5% with osteoporosis; 19–36% with low bone mass) for all three skeletal variables.

The prevalence of osteoporosis and low bone mass at either the femur neck or lumbar spine in 2013–2014 are summarized by race/Hispanic origin and sex in Table 2. Differences in osteoporosis and low bone mass by race and Hispanic origin are illustrated for the combination of the femur neck and lumbar spine rather than for each skeletal site separately because the combined skeletal variable had statistically reliable estimates for the largest number of demographic subgroups. In women, the age-adjusted prevalence of osteoporosis at the femur neck or lumbar spine was highest in non-Hispanic Asians, intermediate in non-Hispanic whites and Hispanics, and lowest in non-Hispanic blacks (Table 2). After adjusting for age, non-Hispanic white and Hispanic women had a significantly higher prevalence of low bone mass at either site than non-Hispanic black women, but the age-adjusted low bone mass prevalence did not differ significantly between women in the other race/Hispanic groups. In men, the age-adjusted prevalence of osteoporosis at the femur neck of lumbar spine did not differ significantly by race/Hispanic origin, but estimates in all but one group had relative standard errors that exceeded 30%, which may have reduced the ability to detect differences. Low bone mass at either skeletal site was significantly higher in non-Hispanic white, Hispanic, and non-Hispanic Asian men than in non-Hispanic black men after adjusting for age, however. Non-Hispanic Asian men also had a significantly higher prevalence of low bone mass at either skeletal site than non-Hispanic white men.

Unadjusted trends in mean femur neck and lumbar spine T-scores between 2005–2006 and 2013–2014 are shown in Figure 1 by sex and survey period. There was a significant quadratic trend in mean femur neck T-score across the survey periods in both men and women. The pattern was roughly an inverted U shape in both sexes, with mean T-score being more positive in the middle two survey periods than in the first or last survey period. Pairwise comparisons revealed the femur neck T-score was significantly lower in 2013–2014 than in 2007–2008 or 2009–2010 in both sexes (data not shown). There was no significant linear or quadratic trend in mean lumbar spine T-score during the same time period in either sex, however. Adjusting for age, race/Hispanic origin and the selected bone-related lifestyle factors did not alter conclusions regarding trends in mean T-score at either skeletal site (data not shown).

Trends in osteoporosis and low bone mass by survey period are shown separately by sex for the femur neck and lumbar spine before and after adjusting for selected risk factors in Table 3. Consistent with findings for mean T-scores, significant trends in poor skeletal status were confined to the femur neck. There were significant quadratic trends in the unadjusted prevalence of femur neck osteoporosis in both sexes. However pairwise differences in femur neck osteoporosis between individual survey periods were confined to women, in whom prevalence in 2007–2008 was signficantly lower than in 2005–2006 or 2013–2014. Adjusting for selected risk factors did not alter conclusions regarding femur neck osteoporosis trends in men, but in women, the quadratic trend was no longer statistically significant ($p<0.06$).

There was also a significant quadratic trend in the unadjusted prevalence of low femur neck bone mass in women (Table 3), with low bone mass at the femur neck being significantly lower in 2007–2008 than in 2013–2014. After adjusting for selected risk factors, the trend in women became linear in shape and more pairwise comparisons became statisticaly significant. Specifically, adjusted femur neck low bone mass in women was significantly lower in both 2007–2008 and 2009–2010 when compared to 2013–2014.

Trends in the selected risk factors used in the multivariate models were examined in order to explore possible reasons for the observed trends in skeletal status. Mean age did not differ significantly between survey period in either sex (data not shown). Figure 2 illustrates age-adjusted trends in other risk factors that were examined in the present study. There was no significant trend in the prevalence of self-reported physician's diagnosis of osteoporosis in either sex. Trends in the other risk factors differed by sex. Smoking declined significantly between 2005–2006 and 2013–2014 in men, but not in women. In contrast, among men, there were no trends in the proportion who drank milk or who had BMI ≥ 25, but in women, milk intake declined significantly over the relevant time period, while the proportion with BMI ≥ 25 increased significantly.

Discussion

Results from the present study indicate that in 2013–2014, osteoporosis at the femur neck or lumbar spine, when considered separately or in combination, affected roughly 6–11% of adults age 50 years and older in the U.S., while low bone mass occurred in roughly 32–46% of these older adults. The present study also provided an updated examination of trends in bone mineral density of the older US population since 2005. An earlier comparison of femur BMD beween NHANES III (1988–1994) and NHANES 2005–2008 suggested that femur neck BMD had improved since 1988, but that comparison was confounded by a major change in DXA technology (from pencil-beam to fan-beam) between the surveys which could not be fully addressed (1, 9). In contrast, the present study focused on a more recent time period in which bone density was measured by fan-beam in all survey periods being compared. We found mixed results regarding skeletal status trends in older US adults. Specifically, there was some evidence of a shift toward poorer skeletal status at the femur neck BMD since 2005, but there was no evidence of change in lumbar spine status during the same time frame.

The reason for the lack of consistent trends in the two skeletal sites is not clear. Bone loss patterns may differ between these two skeletal sites (10), which can lead to discrepancies in skeletal status (11). Lumbar spine bone density measurements by DXA may also be more affected by artifacts such as aortic calcification and osteophytes, than the femur neck. Another possible factor for the inconsistent trends observed between femur neck and spine specific to the present study, namely a change in software to process femur scans but not spine scans between survey periods, seems unlikely to have played a role, since conclusions regarding femur neck trends were similar after adjusting for the software change.

Trend tests indicated an overall significant trend, either quadratic or linear, in mean femur neck T-score andosteoporosis in both sexes and in femur neck low bone mass in women, but significant pairwise differences in osteoporosis or low bone mass between the individual survey periods were most consistent between 2007–2008 and 2013–2014. Since statistically significant differences were primarily limited to these two survey periods, it is possible that the prevalences observed in one of these two periods reflects a random fluctuation in femur neck status. However, while not statistically different, the osteoporosis and low bone mass estimates in 2013–2014 were slightly higher than in the other three earlier time periods as well, which is more consistent with an overall trend towards poorer status over time. Data on femur neck status from future cycles of NHANES can likely provide better clarification of the nature of trends in femur neck status.

Reasons for the observed femur neck trends are not clear. Adjusting for changes in demographic variables and selected bone-related risk factors between survey periods did not appreciably alter conclusions regarding trends, as would be expected if these factors played a major role in the observed changes in skeletal status. The lack of impact of these adjustments may reflect the fact that, of the trends in confounding variables considered, only the trend in milk intake among women changed in a manner consistent with reduced bone density (e.g., milk intake declined in women during the time period between 2005- and 2014).

Introduction of oversampling of non-Hispanic Asians in NHANES 2013–2014 could theoretically have an impact on observed trends, since Asians generally have lower BMD than non-Asians (12, 13). However use of sample weights in analyses ensured that trend results reflected the proportion of non-Hispanic Asians in the total population, which was estimated as 4.9% in 2012 —this small proportion is unlikely to be able to shift the BMD distribution of the overall population. In addition, similar trends were observed in secondary analysis which focused on non-Hispanic whites only, which further suggests that the introduction of oversampling of Asians in 2013–2014 did not account for the observed trends.

There was no change in self-reported physician’s diagnosis of osteoporosis between survey periods in the present study, but some researchers have raised concerns about changes in medical care for osteoporosis due to changes in Medicare reimbursement for DXA that were implemented in 2007 (14–20). For example, analyses of claims data indicated a decline in utilization of DXA scans in both the Medicare population (20) and in younger commercially-insured postmenopausal women (21) during the time period that coincided

temporally with the reduction in reimbursement for DXA scans offered at outpatient sites (18). Other researchers have noted a decline in bisphosphonate prescriptions between 2007–2008 and 2012 in the U.S. (22), which coincided temporally with increases in media reports and internet searches about safety concerns associated with these drugs in an ecological analysis (23). These possibilities could not be examined in further detail in the present study because variables related to medical care of osteoporosis other than the self-reported physician's diagnosis were either not collected (e.g., medical records) or were not available for all survey cycles at the time of analysis (e.g., prescription medication use).

In addition to updating estimates of osteoporosis and low bone mass since 2010, this study provides the first nationally representative estimates of osteoporosis and low bone mass at either the femur neck or lumbar spine in non-Hispanic Asians. We found that the age-adjusted prevalence of osteoporosis at either skeletal site was higher in non-Hispanic Asian women than in all other race/Hispanic origin groups examined and that non-Hispanic Asian men had a higher prevalence of low bone mass than both non-Hispanic white and non-Hispanic black men. It is important to note that these findings are based on a comparison of BMD values of non-Hispanic Asians with reference data from young non-Hispanic white women. Both WHO and ISCD have recommended that Caucasian reference data be used when diagnosing these conditions in non-whites (4, 6). However some researchers have questioned the use of Caucasian reference data to define low skeletal status in Asians, in light of their smaller body size and lower hip fracture risk (24). Since Asians have lower BMD than many non-Asian groups, use of Asian reference data results in lower prevalence estimates. For example, Walker et al (25) found that prevalence of osteoporosis at the lumbar spine and femur neck, when considered separately, in older Chinese American women were 16–17 percentage units lower when based on young Chinese American female reference data than on Caucasian data. However, it is not clear whether Asians have a lower risk of fracture at all skeletal sites, as some studies have found similar or higher vertebral vertebral fracture risk in Asians as in Caucasins (26, 27). Furthermore, the non-Hispanic Asian group in NHANES 2013–2014 consisted of a mixture of different Asian groups, including individuals of Chinese, Asian Indian, Korean, Filipino, Vietnamese, and Japanese descent. There are some data to suggest that BMD may vary between Asian subgroups, which complicates the choice of the appropriate Asian reference database to use for a group with this mixture.

Study limitations include the ability to examine the impact of only a limited number of potential explanatory variables for observed trends, either because they were not available for use at the time of the present study for all four survey periods or were not measured. Other limitations include possible nonresponse bias in the estimates. Nonresponse bias due to refusal to participate in the physical examinations in NHANES is reduced by a nonresponse adjustment factor included in the calculation of the sample weights for use with examinee data. However, 24% of examined respondents did not have usable femur and spine BMD data, and this is not addressed by the those sample weight adjustments. Results from the analysis in which sample weights were adjusting for missing data by age, sex, and race/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 at-risk group for osteoporosis, are not included in the NHANES sampling frame by design.

In conclusion, osteoporosis affected 6–11% of adults age 50 years and older in the US in 2013–2014, which translate to roughly 1 in every 9–17 adults. The prevalence of osteoporosis in 2013–2014 was higher in non-Hispanic Asians than in all (in women), or most (in men) of the other race/Hispanic origin groups examined when defined using young, white female reference data. There was some evidence of a decline in femur neck status of older US adults since the middle of the last decade, but lumbar spine status did not change during the same time period. The reason for the discrepancy between observed trends in femur neck versus lumbar spine status is not clear. Similarly, the factors underlying the possible trend in femur neck status are not clear, as adjusting for changes in body mass index, smoking, milk intake, and physician's diagnosis of osteoporosis between surveys did not appreciably alter conclusions. More work is needed to confirm the observed trends and identify possible explanatory factors.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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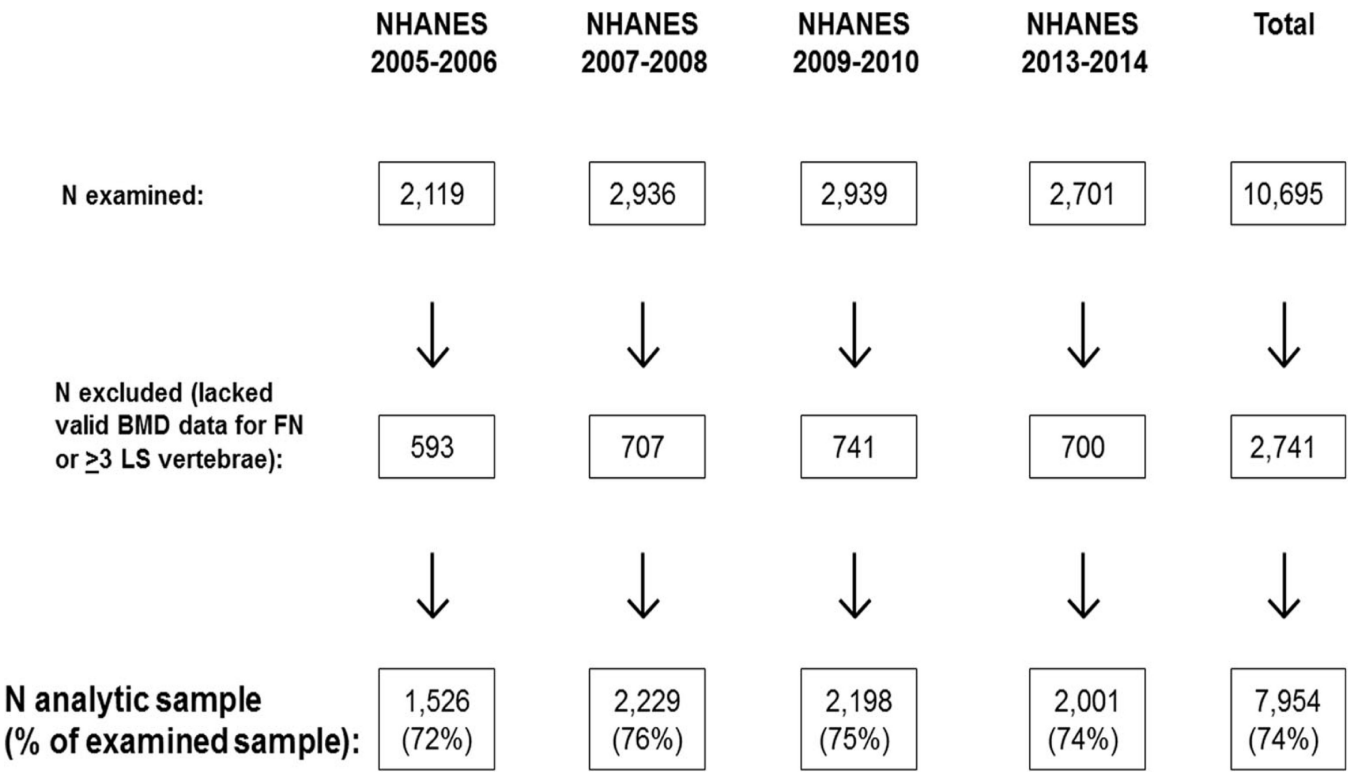

Figure 1.
Flow chart showing sample sizes for the examined, excluded, and analytic sample by survey cycle

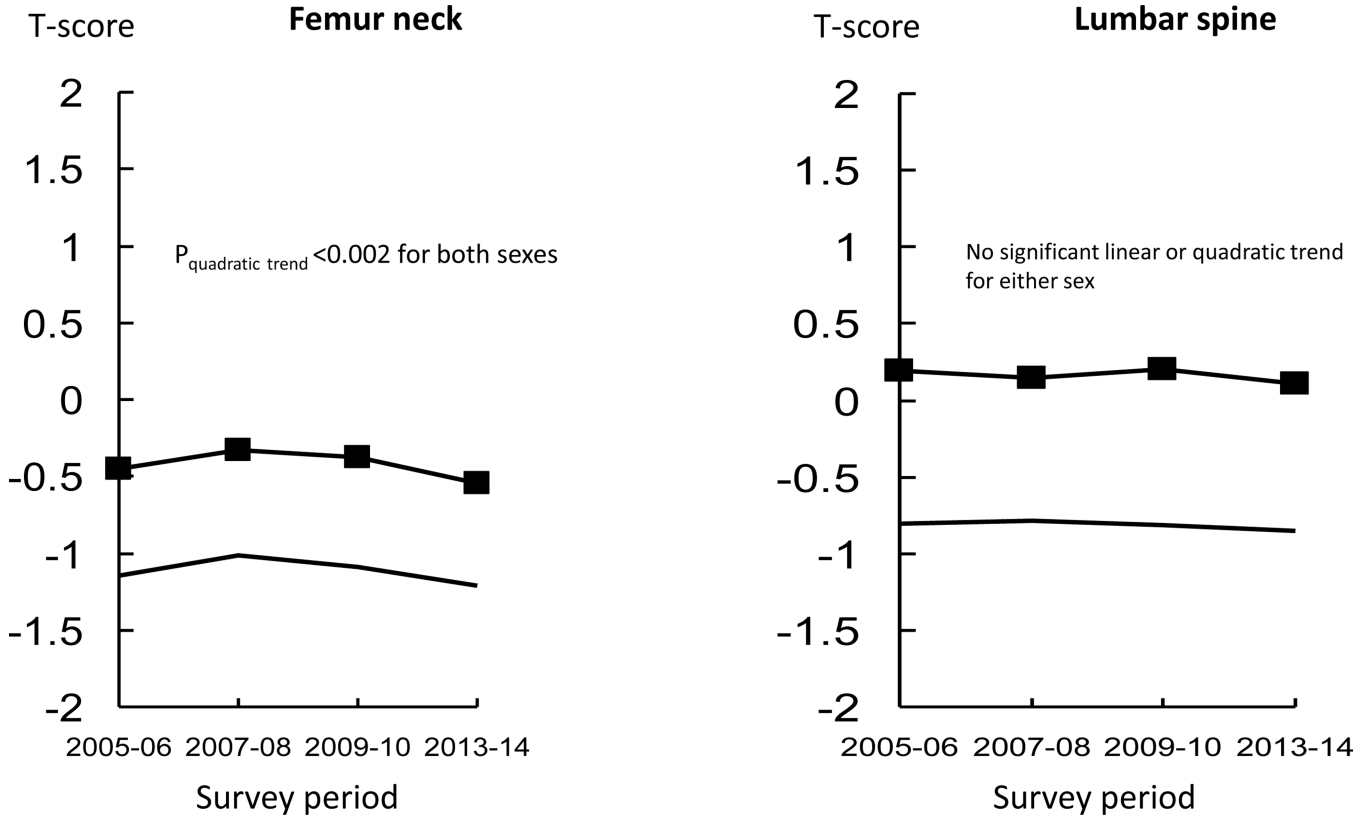

Figure 2.

Unadjusted mean T-score at the femur neck and lumbar spine by sex and survey period, NHANES 2005–2014

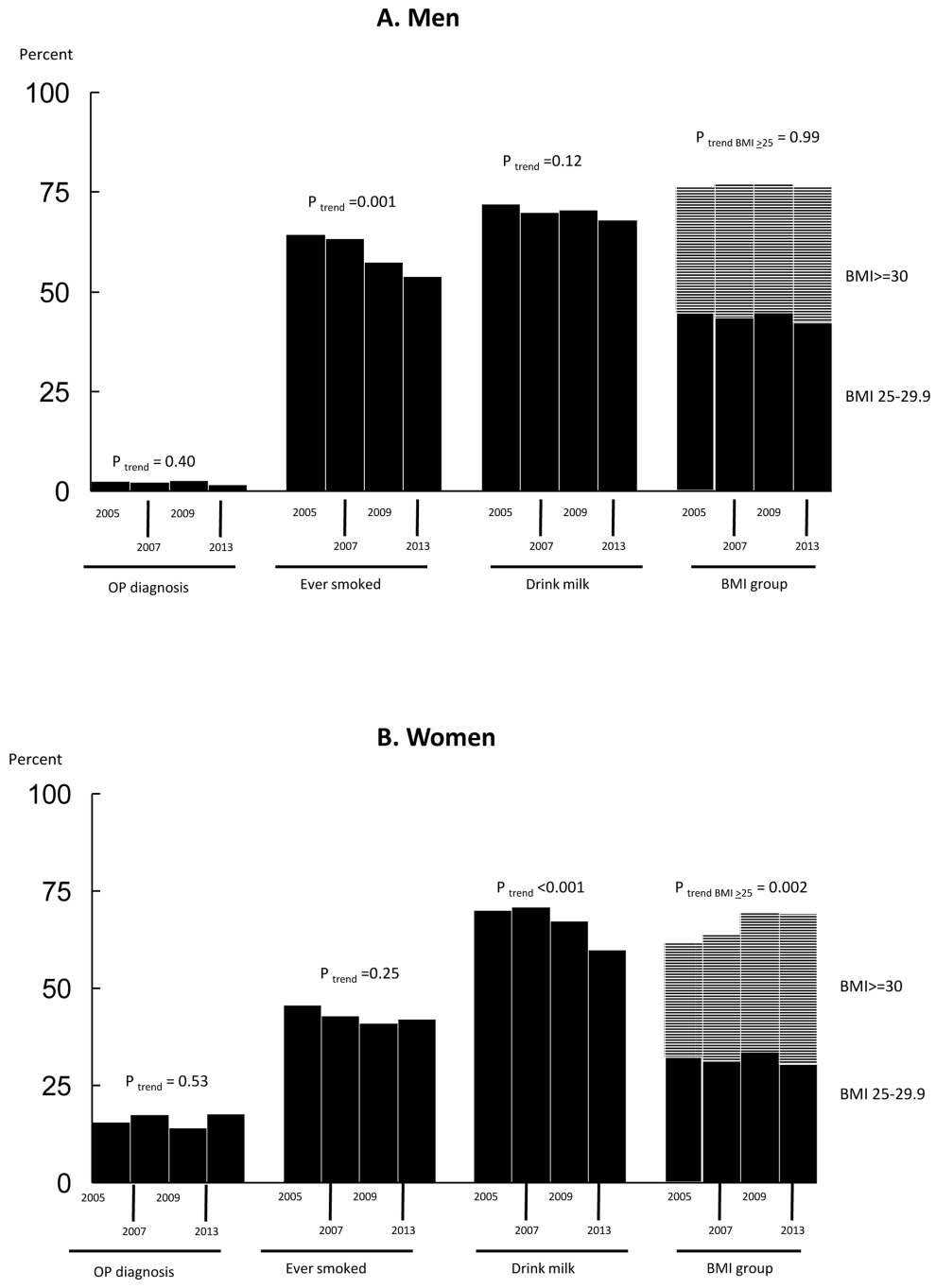

Figure 3.

Age-adjusted prevalence of selected risk factors by sex and survey period, NHANES 2005–2014

Table 1

Prevalence of osteoporosis and low bone mass at femur neck and lumbar spine Adults age 50+ years, NHANES 2013–14

		Femur neck		Lumbar spine		Either femur neck or lumbar spine	
	n	Percent	SE	Percent	SE	Percent	SE
Osteoporosis							
Both sexes	2001	6.3	0.6	7.8	0.4	11.0	0.7
Women	1029	9.8	1.1	11.6	1.0	16.5	1.2
Men	972	2.5	0.5	3.6	0.7	5.1	0.7
p value, sex		<0.001		<0.001		<0.001	
Low bone mass							
Both sexes	2001	42.8	1.0	27.9	1.5	44.5	1.0
Women	1029	52.6	1.5	35.9	1.7	52.6	1.1
Men	972	32.1	1.3	19.2	1.8	35.6	1.3
p value, sex		<0.001		0.005		0.001	

SE=Standard error

Table 2

Prevalence of osteoporosis and low bone mass at either the femur neck or lumbar spine by sex and race/Hispanic origin,Adults age 50+, NHANES 2013–14

		Osteoporosis				Low bone mass			
		Unadjusted		Age-adjusted†		Unadjusted		Age-adjusted†	
	n	Percent	SE	Percent	SE	Percent	SE	Percent	SE
Women									
Non-Hispanic white	473	16.0	1.7	17.0[a,b]	1.7	50.6	2.2	54.6[a]	1.4
Non-Hispanic black	202	8.0[2]	2.7	8.2[1;a,,c,d]	2.7	37.1	3.1	40.4[a,b]	3.2
Hispanic	215	17.4	3.0	20.5[c,e]	3.1	59.4	4.4	57.0[b]	3.3
Non-Hispanic Asian	119	38.8	3.1	40.0[b,d,e]	5.5	47.9	5.4	47.0	5.3
Men									
Non-Hispanic white	412	5.3	0.8	6.0	0.8	36.6	1.6	37.3[a,b]	1.3
Non-Hispanic black	219	**	**	**	**	21.6	3.1	25.7[a,,c,d]	3.4
Hispanic	213	4.2[2]	1.6	5.9	2.7	35.2	3.7	38.1[c]	4.7
Non-Hispanic Asian	113	6.5[1]	2.2	7.5	2.2	51.3	4.3	47.7[b,d]	4.7

SE= standard error

† Prevalence estimates are age-adjusted to the 2000 Census using the direct method. Age-adjusted prevalence estimates sharing common letter superscripts within sex differ significantly, p<0.05

[1] Relative standard error = 30–39%

[2] Relative standard error = 40–49%

** Relative standard error >=50%

Table 3

Prevalence of osteoporosis or low bone mass at femur neck or lumbar spine by sex and survey period Adults age 50+ years, NHANES 2005–2010 and 2013–2014

		Femur neck								Lumbar spine							
		Osteoporosis				Low bone mass				Osteoporosis				Low bone mass			
		Unadjusted		Multivariate adjusted[1]		Unadjusted		Multivariate adjusted[1]		Unadjusted		Multivariate adjusted[1]		Unadjusted		Multivariate adjusted[1]	
	n	Percent	SE	Percent	SE	Percent	SE	Percent	SE	Percent	SE	Percent	SE	Percent	SE	Percent	SE
Women																	
2005–06	701	9.5[a]	1.0	8.3	0.8	49.6	2.3	47.8	2.4	11.2	1.0	10.5	1.0	35.0	1.7	34.1	1.8
2007–08	1081	6.1[a,b]	0.8	6.1	0.8	46.0[a]	1.4	45.5[a,b]	1.3	8.9	0.9	8.9	0.8	37.4	1.7	37.5	1,6
2009–10	1069	7.6	0.7	8.5	1.0	48.9	1.3	49.8[a,c]	1.3	10.4	0.9	11.1	1.0	36.5	2.2	36.9	2.3
2013–14	1029	9.8[b]	1.1	9.9	1.1	52.6[a]	1.5	53.4[b,c]	1.3	11.6	1.0	11.6	1.2	35.9	1.7	36.2	1.7
p linear		0.57		0.10		0.16		0.01		0.51		0.27		0.81		0.49	
p quadratic		0.003		0.06		0.04		0.06		0.07		0.30		0.42		0.28	
Men																	
2005–06	825	2.0	0.4	2.0	0.4	30.3	1.5	29.1	1.5	2.8	0.8	2.8	0.7	17.8	1.4	17.6	1.4
2007–08	1148	1.4	0.4	1.5	0.4	27.3	1.2	27.4[a]	1.3	2.4	0.4	2.3	0.4	18.0	1.9	17.9	2.0
2009–10	1129	1.5	0.4	1.4	0.4	29.9	2.0	29.8	1.5	3.2	0.7	3.2	0.6	19.1	1.9	18.6	1.7
2013–14	972	2.5	0.5	2.5	0.5	32.1	1.3	33.0[a]	1.4	3.6	0.7	3.9	0.8	19.2	1.8	19.5	1.8
p linear		0.36		0.42		0.20		0.03		0.33		0.20		0.49		0.38	
p quadratic		0.05[2]		0.04[2]		0.09		0.09		0.55		0.37		0.98		0.86	

SE=standard error.

Means and percents within sex sharing common letter superscripts differ significantly, p<0.05

[1]Adjusted for age, race/Hispanic origin, body mass index, smoking, milk intake, and self-reported physician's diagnosis of osteoporosis.

[2]Overall trend was statistically significant, but no pairwise difference was statistically significant.