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Age-related decline in bone density among ethnically diverse older men

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Abstract

Summary—We compared rates of BMD decline in older men of diverse ethnic backgroud. The rate of bone loss was statistically equivalent between men of African and Caucasian descent.

Introduction—Race differences in peak bone mineral density (BMD) are well established, but the magnitude of bone loss among non-white men has not been well characterized. Our objective was to compare and contrast the rates of decline in BMD with aging among older men of different race/ethnic groups.

Methods—The rate of decline in hip BMD was measured by dual-energy X-ray absorptiometry (Hologic QDR-4500 W) with an average follow-up of 4.6 years in 3,869 Caucasian, 138 African American, 145 Asian, and 334 Afro-Caribbean men aged≥65 years (Mean ages: 73±5, 70±4, 72±5, 71±5 years, respectively).

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Conflicts of interest None.

Results—The annual rate of decline in BMD at the femoral neck was −0.32%, −0.42%, −0.09%, and −0.44%/year for Caucasian, African American, Asian, and Afro-Caribbean men, respectively (p<0.05 for Caucasian versus Asian). Although men of African ancestry have higher peak BMD than Caucasians, rates of decline in BMD with aging appear to be statistically equivalent in our study. In contrast, Asian men experienced a slower rate of decline in BMD compared with Caucasians and African Americans.

Conclusion—More studies are needed to better define the natural history of and factors associated with bone loss among non-white men.

Keywords

BMD; Bone loss; Men; Osteoporosis; Race

Introduction

Although osteoporosis is more prevalent among women than men, men also experience substantial bone loss and an increase in fracture incidence with advancing age. With the increase in life expectancy, more men throughout the world are expected to develop osteoporosis and its associated fractures [1, 2] including non-white men [3]. Although osteoporosis is less prevalent in men of African ancestry, this population group is expected to comprise a growing proportion of incidence and economic burden of osteoporosis-related fractures over the next 20–50 years in both the USA [4] and world-wide [3].

Men of African descent have a higher peak BMD than Caucasians, Mexicans Americans, and Asians [5, 6]. However, little information exists about bone loss with aging among non-white men. Most longitudinal studies of osteoporosis have been conducted among Caucasian men in North America [7–13], Europe [14–17], and Australia [18]. The low prevalence of osteoporosis in men of African ancestry has led to the belief that they experience a slower loss of BMD with aging than other race/ethnic groups. To our knowledge, only one longitudinal study has compared the magnitude of BMD loss in African-American and Caucasian men, and found a greater rate of BMD decline in Caucasians [19].

To address the lack of knowledge on age-related bone loss in non-white men, we combined data from two longitudinal studies of white, black, and Asian men from the USA (Osteoporotic Fractures in Men Study (MrOS)) and black men from the Caribbean island of Tobago (Tobago Bone Health Study). We tested the hypothesis that black men would experience the lowest rates of decline in BMD compared with other race/ethnic groups.

Methods

Study population

The MrOS study enrolled 5,995 participants from 2000 to 2002. Details of the study have been published [20, 21]. In brief, men who were aged 65 years and older, able to walk without assistance from another person, and had no bilateral hip replacement surgery were recruited via targeted mailing based on motor vehicle registration, voter registration, and veteran's administration data base. Recruitment took place at six academic medical centers: Birmingham, AL; Minneapolis, MN; Palo Alto, CA; Pittsburgh, PA; Portland, OR; and San Diego, CA. The proportions of minorities enrolled at each clinic site were generally representative of the local population of older men by US Census data. From 2005 to 2006, men enrolled in the initial visit were invited to complete a follow-up exam. Of those 5,229 (96% of the survivors) who returned for the second visit, 4,373 were of Caucasian, African American, and Asian American ancestry, and had complete BMD data.

The Tobago Bone Health Study was conducted on the Caribbean island of Tobago in 2000 [6, 22]. Briefly, recruitment was accomplished by word of mouth, hospital flyers, and radio broadcasting. A total of 2,652 men who were at least 40 years of age, ambulatory, and not terminally ill, and had not had bilateral hip replacement were initially recruited. The self-reported ethnicity of the cohort is 97% African, 2% East Indian, <1% white, and <1% "other". In 2004, participants were re-contacted for a follow-up exam. A total of 1,748 men (70% of survivors) returned for the follow-up exam. In order to have a comparable age distribution between cohorts for the current analysis, we restricted the analysis of the Tobago cohort to men aged ≥65 years at the baseline exam and who had four African ancestry grandparents. The institutional review boards (IRB) at each MrOS center and IRB at the University of Pittsburgh and the Tobago Ministry of Health and Social Services approved the study protocols. Written informed consent was obtained from all participants.

Densitometry

In Tobago and each clinical site of MrOS, areal BMD (g/cm^2) of the total hip and femoral neck was measured using dual energy X-ray absorptiometry (DXA) with a Hologic QDR 4500 W densitometer (Hologic, Inc., Bedford, MA) at both visits. DXA scans were performed by trained and certified technicians and a strict protocol was followed. Phantoms were scanned daily to monitor machine performance and longitudinal stability. A weekly print out of quality control plots was generated to detect short-term inconsistencies and long-term drift. A single set of phantoms was scanned on all machines to provide the cross-calibration data. Corrections for any statistically significant differences across scanners were applied to participant BMD values. BMD values were also corrected for longitudinal shifts, based on scanning the Hologic spine phantom. The phantom was scanned five times on the same day and was analyzed centrally by the same research assistant for each DXA scanner. The inter-scanner CV of 0.5% for BMD was within expected limits.

DXA provides a 2-dimensional measure of BMD that is unable to capture the depth of bone. Ethnic and racial differences in bone size are known to exist and may potentially contribute to the variations in BMD observed between ethnicities/races. To address this potential issue, bone mineral apparent density (BMAD; in g/cm^3) at the femoral neck was calculated to provide an estimation of volumetric BMD. BMAD was calculated using following formula: $BMAD=BMC/CSA^2$ [23].

Baseline characteristics

Questionnaires were administered to obtain information on demographic characteristics, medical history, and lifestyle factors. Self-reported and interview approaches were used in the MrOS and Tobago studies. Body weight in both studies was measured in kilograms using balance beam scales (a digital scale was used at the MrOS Portland site). Height was measured in centimeters using a wall-mounted height board in Tobago and stadiometers in MrOS studies.

Statistical analysis

Change in BMD, BMAD, BMC, and CSA was expressed as an absolute change per year and percent change per year. Absolute change per year was calculated as the difference between baseline and follow-up bone measures divided by the follow-up duration in years. Percent change per year was calculated as percent change of bone measure from baseline divided by the follow-up duration in years. To evaluate the possibility of bias from men who did not return for the follow-up exams, we compared unadjusted mean age, anthropometric measures and bone measures (using *t* test) as well as the prevalence of diabetes, prostate cancer, and smoking (using Chi-square test) between participants and non-participants within each race group. To evaluate the overall and pair-wise differences of baseline

characteristics between the four ethnic groups, analysis of variance were used for continuous variables, and Mantel–Haenszel Chi-square test and logistic regression were used for categorical variables. To compare absolute and percent change per year in bone measures by ethnicity, analysis of covariance was used with age-adjusted and multivariable-adjusted models. The multivariable-adjusted model included baseline age, MrOS clinic site, height, body weight, corresponding baseline bone measure, diabetes, fracture, prostate cancer, current smoking status, and percent weight change from baseline to follow-up visits. These variables were selected based on their potential influence on the rate of decline in BMD. All analyses were conducted with Statistical Analysis System (SAS; version 9.1; SAS Institute, Cary, NC).

The prevalence of prostate cancer is greater among black men [22, 24] and its treatment by androgen deprevation therapy (ADT) has a profound impact on BMD [25–32]. Thus, in order not to bias the results by the race differences in the prevalence of ADT, we excluded men who reported a history ADT (MrOS, 2.1%; Tobago Afro-Caribbeans, 16.5%). Our final analyses were based on 3,869 Caucasians, 138 African Americans, 145 Asian Americans, and 334 Afro-Caribbean men.

Results

In general, Afro-Caribbean and Asian American men were shorter, weighed less and had lower BMI than Caucasian men (Table 1). African American men had similar height and body weight, but statistically greater BMI, than Caucasian men. The prevalence of diabetes and prostate cancer was significantly higher, and the prevalence of fractures was significantly lower among men of African compared with Caucasian ancestry.

Baseline bone measures

Afro-Caribbean men had the highest total hip BMD followed by African American, Caucasian, and Asian American men (Table 2). The difference between Caucasians and Asian Americans disappeared in the model adjusted for age, study site, body weight, height, diabetes, prostate cancer, fracture, and current smoking status. Femoral neck BMAD followed similar patterns, except that there was no difference between Asian American and Caucasian men in any model. For femoral neck BMC, men of African descent appeared to have greater BMC than their Caucasian counterparts. Femoral neck CSA was highest among Caucasian men, but lowest among Afro-Caribbean men.

Rate of BMD loss

Men of Caucasian and African ancestry experienced a significant decline in hip BMD and BMAD during follow-up, ranging from 0.26% to 0.44%/year for total hip, 0.32% to 0.54%/year for femoral neck, and 0.40% to 0.57%/year for femoral neck BMAD (Table 3). Among Asian American men, BMD declined significantly only at the total hip and with a relatively smaller magnitude than the other groups. At the total hip, the rate of decline in BMD was similar among Caucasian, African American and Afro-Caribbean men. Afro-Caribbean men had a significantly greater rate of decline in femoral neck BMD than Caucasian men in crude and age-adjusted models. However, this difference was no longer statistically significant in the fully adjusted model. None of the factors from the full model individually explained the attenuation in these race differences, but rather the combination of body weight, weight change, diabetes, smoking, and clinic site attenuated the difference by 37% (data not shown). No differences in the rate of decline in femoral neck BMAD were observed among Caucasian, African American and Afro-Caribbean men. Analyses of the absolute rate of decline in BMD yielded similar patterns (data not shown). We also excluded

corticosteroid users and repeated analyses of BMD loss. The results were similar and thus these men have been retained in the analysis (data not shown).

Discussion

We found substantially higher hip BMD at baseline among men of African compared with Caucasian and Asian Ancestry consistent with previous studies [5, 6, 33–38]. However, we also observed that Afro-Caribbean men, a less admixed population than African Americans [39], had higher BMD and BMAD than African American men. Despite their higher initial BMD at the total hip and femoral neck, African American and Afro-Caribbean men experienced a similar annualized absolute and percentage rate of decline in BMD as Caucasians. Over the approximately 4.5-year follow-up, Caucasian, African American, and Afro-Caribbean men lost BMD at an average of 0.26% to 0.54% per year, compared with only 0.09% to 0.21% among Asian American men.

Most longitudinal studies of age-related declines in BMD among men have predominately included Caucasians [7–9, 11, 14, 16–18, 40]. Although it is difficult to directly compare BMD changes across studies due to the different study designs and population characteristics, the rates of decline in BMD in our study were very similar to those observed among Caucasians in these studies [8, 11, 17]. For example, the Framingham Osteoporosis Study reported a rate of femoral neck BMD decline of 0.38% per year among 278 Caucasian men aged 67–90 years [8]. The Rancho Bernardo Study reported a 0.34% per year decline in femoral neck BMD in 507 Caucasian American men aged 45–92 years [11]. Dennison and colleagues demonstrated a 0.31%, 0.30%, and 0.06% per year decline in femoral neck BMD among 173 British men aged 60–64, 65–69, and 70–74 years, respectively [14]. However, the rate of decline for the 65–69- and 70–74-year olds did not reach statistical significance likely due to small sample size. The Dubbo Study of Australian men reported a much greater decline in femoral neck BMD (0.85% per year) than the aforementioned studies [18]. Melton et al. reported a 0.52% per year increase in femoral neck BMD among men aged 50–69 years, but a 0.19% per year decline among men aged≥70 years [9].

Ethnic differences in BMD changes with aging are not well defined among older men. In the Baltimore Men's Osteoporosis Study, the rate of decline in femoral neck BMD was 2.1% per year in 349 Caucasian and 1.1% per year in 119 African American men aged 60–74 years [19]. Rates of decline in BMD in this study were much higher than our findings and those previously reported in Caucasian men [7–9, 11, 14]. Longitudinal studies of BMD changes among older Asian and Asian American men are also sparse. A study of 142 Taiwanese men aged 65 years and older found a mean femoral neck BMD loss of 1.87% per year [41], which was approximately six and 20 times higher than what we observed among Caucasian and Asian American men. Our study observed no or minimal change in hip BMD measures with age among Asian American men. It may be that Asian American men lose BMD at such a slow rate that 4.5 years of follow-up was not sufficient to detect a significant BMD decline. It is also possible that the decline in BMD occurs at a later age among Asian American men than in other racial/ethnic groups. However, the number of Asian American men in our study was small and may have been insufficient to detect a significant change in BMD.

We utilized two well-characterized cohorts with excellent participation rates to examine rates of BMD loss in older men. Both cohorts used the same DXA manufacturer and model scanner, and scanners were cross-calibrated. Although the number of non-white US participants was small, we supplemented our analysis with data from the Tobago Bone Health Study, where more than 300 Afro-Caribbean men aged 65 years and older were enrolled. Nonetheless, the number of non-white men in this analysis was much smaller than

the number of Caucasians and there was lower power to detect differences between non-white groups of men.

In conclusion, the present study evaluated BMD and age-related decline in BMD at the hip among non-white men aged 65 years and older. We found that despite their initially higher BMD, African ancestry men experienced a similar rate of loss in hip BMD with age compared with Caucasian ancestry men. We also found a minimal decline in BMD among Asian American men. Further research is needed to understand the natural history of and factors associated with BMD loss among non-white men.

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Table 1

Baseline characteristics among older men

Characteristics	Caucasian (*n* = 3,869)	African American (*n* = 138)	Asian American (*n* = 145)	Afro-Caribbean (*n* = 334)	Overall *p* value
Follow-up period (years)	4.6±0.36	4.5±0.30[a]	4.4±0.26[a]	4.3±0.77[a]	<.0001
Age (years)	72.9±5.4	70.4±4.3[a]	72.4±4.9	71.3±5.1[a]	<.0001
Height (cm)	174.8±6.5	174.7±7.5	167.0±5.8[a]	171.4±6.0[a]	<.0001
Body weight (kg)	83.5±12.1	86.9±15.0	70.0±9.0[a]	79.2±13.0[a]	<.0001
BMI (kg/m^2)	27.2±3.4	28.3±4.1[a]	25.1±3.0[a]	26.8±3.9[a]	<.0001
Fat mass (kg)	21.6±6.5	21.5±7.0	16.4±4.4[a]	16.6±6.1[a]	<.0001
Percentage fat mass (%)	26.1±5.2	25.1±5.0[a]	23.7±4.4[a]	21.3±5.6[a]	<.0001
Diabetes (%)	8.5	20.3[a]	15.8	20.5[a]	<.0001
Prostate cancer (%)	8.8	16.7	9.7	20.1[a]	<.0001
Ever fracture (%)	56.5	45.7[a]	35.9	16.1[a]	<.0001
Ever smoke (%)	60.8	63.0[a]	55.2	38.6[a]	<.0001
Currently smoke (%)	2.8	9.4[a]	2.1	6.3	.0003
Weight change (%)	–1.53±5.1	–1.25±5.6	–1.16±4.4	–1.37±7.2	.7464
Gain (≥5%)[b]	9.0 (7.5)	14.1 (8.1)	9.1 (7.7)	17.3 (9.1)[a]	<.0001
Stable (–5 to +5%)[b]	68.6 (–0.4)	65.9 (–0.9)	72.7 (–0.9)[a]	55.6 (–0.5)[a]	<.0001
Lost (≤–5%)[b]	22.4 (–8.5)	20.0 (–8.9)	18.2 (–6.8)	27.2 (–9.8)[a]	.1176

Values are unadjusted mean±SD or prevalence

[a] Pairwise *p* values were significantly different from Caucasians

[b] Values are prevalence (mean weight change) in that group

Table 2

Baseline bone measures among older men (mean±SD)

	Caucasian (*n*=3,869)	African American (*n*=138)	Asian (*n*=145)	Afro-Caribbean (*n*=334)
Total hip BMD (g/cm^2)				
Unadjusted	0.96±0.13	1.05±0.15[a]	0.91±0.12	1.11±0.14[a]
Age-adjusted	0.96	1.04[a]	0.91	1.10[a]
Multivariable adjusted	0.96	1.03[a]	0.96	1.09[a]
Femoral neck BMD (g/cm^2)				
Unadjusted	0.78±0.12	0.94±0.14[a]	0.75±0.11	0.94±0.14[a]
Age-adjusted	0.78	0.89[a]	0.75	0.93[a]
Multivariable adjusted	0.78	0.88[a]	0.79	0.93[a]
Femoral neck BMC (g)				
Unadjusted	4.46±0.70	4.82±0.84[a]	4.03±0.66[a]	4.86±0.78[a]
Age-adjusted	4.46	4.82[a]	4.03[a]	4.86[a]
Multivariable adjusted	4.44	4.80[a]	4.42	4.88[a]
Femoral neck CSA (cm^2)				
Unadjusted	5.71 ±0.40	5.46±0.41[a]	5.37±0.39[a]	5.24±0.41[a]
Age-adjusted	5.71	5.46[a]	5.37[a]	5.24[a]
Multivariable adjusted	5.70	5.49[a]	5.61[a]	5.28[a]
Femoral neck BMAD				
Unadjusted	0.14±0.02	0.16±0.03[a]	0.14±0.02	0.18±0.03[a]
Age-adjusted	0.14	0.16[a]	0.14	0.18[a]
Multivariable adjusted	0.14	0.16[a]	0.14	0.18[a]

Multivariate model: adjusted for study site, baseline age, body weight, height, diabetes, prostate cancer, fracture, and current smoking status

[a]Pairwise *p* values were significantly different from Caucasians

Table 3

Annualized rate of change (%/year) in bone measures among older men

	Caucasian (*n*=3,869)	African American (*n*=138)	Asian (*n*=145)	Afro-Caribbean (*n*=334)
Total hip BMD				
Unadjusted	*–0.34 (–0.36, –0.31)*	*–0.37 (–0.50, –0.24)*	–0.13 (–0.25, 0.00)*	*–0.35 (–0.25, –0.27)*
Age-adjusted	*–0.33 (–0.36, –0.31)*	*–0.44 (–0.57, –0.31)*	*–0.13 (–0.26, –0.01)**	*–0.39 (–0.47, –0.31)*
Multivariable adjusted	*–0.34 (–0.36, –0.31)*	*–0.39 (–0.52, –0.27)*	*–0.19 (–0.32, –0.07)**	*–0.26 (–0.36, –0.17)*
Femoral neck BMD				
Unadjusted	*–0.32 (–0.36, –0.29)*	*–0.39 (–0.56, –0.23)*	–0.10 (–0.26, 0.06)*	*–0.51 (–0.62, –0.41)**
Age-adjusted	*–0.32 (–0.35, –0.29)*	*–0.44 (–0.60, –0.27)*	–0.10 (–0.26, 0.06)*	*–0.54 (–0.65, –0.43)**
Multivariable adjusted	*–0.32 (–0.35, –0.29)*	*–0.42 (–0.59, –0.26)*	–0.09 (–0.26, 0.08)*	*–0.44 (–0.57, –0.30)*
Femoral neck BMAD				
Unadjusted	*–0.48 (–0.52, –0.43)*	*–0.48 (–0.71, –0.25)*	–0.19 (–0.42, 0.03)*	*–0.55 (–0.70, –0.40)*
Age-adjusted	*–0.47 (–0.52, –0.43)*	*–0.52 (–0.75, –0.29)*	–0.20 (–0.42, 0.02)*	*–0.57 (–0.72, –0.42)*
Multivariable adjusted	*–0.48 (–0.52, –0.44)*	*–0.44 (–0.66, –0.21)*	–0.21 (–0.44, 0.02)*	*–0.40 (–0.58, –0.21)*

Values are adjusted mean and 95% confidence interval. Entries in italics: changes in bone measure were significantly different from zero. Multivariate model: adjusted for study site, baseline age, body weight, height, initial bone measure, weight change, diabetes, prostate cancer, fracture and current smoking status

* $p<0.05$ compared with Caucasians