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Risk Factors for 5-year Prospective Height Loss Among Postmenopausal Women

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Abstract

Objective—Height loss is common in older women and has been associated with increased morbidity and mortality. In this study we identified factors that could predict prospective height loss in postmenopausal women.

Methods—Height was measured in 1,024 postmenopausal women, enrolled in the Buffalo Osteoporosis and Periodontal Disease Study, at baseline and 5 years later using a fixed stadiometer. Demographics, lifestyle, medical history and medication use were assessed at baseline. Stepwise logistic regression was used to identify factors that are associated with marked height loss of ≥ 1 inch. Odds ratios (OR) and 95% confidence intervals (CI) were estimated for each predictor. Receiver operating characteristic (ROC) curve was performed to determine the discriminatory ability of the prediction model.

Results—The mean loss of height was 0.4 (SD=0.7) inches. Age (OR=1.11, 95% CI: 1.06-1.16), weight (OR=1.05, 95% CI: 1.03-1.07), use of oral corticosteroids (OR= 4.96, 95% CI: 1.25-19.72), and strenuous exercise at age 18 ≥ three times per week (OR= 0.55, 95% CI: 0.31-0.98) were significantly associated with marked height loss in the multivariable-adjusted model. The area under the ROC curve is 72.1%. Addition of bone mineral density measures did not improve the discriminatory ability of the prediction model.

Conclusion—This set of available variables may be useful in predicting the 5-year risk of height loss of 1 inch or more in postmenopausal women. These findings may help to target older women at risk of height loss who may benefit most from prevention strategies for fracture and mortality.

Keywords

Height loss; risk factors; postmenopausal women; cohort study

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Introduction

Adult height is thought to reflect genetic and environmental factors such as early life nutrition, and has been reported to be associated with cancer mortality and circulatory disease.¹ Adults lose height as they age,² and this decline is more marked in women than in men.³ In previous studies, height loss has been linked to increased risk of health outcomes in women, such as total and hip fractures,^{4–6} digestive problems,⁷ urinary incontinence,⁷ low quality of life,^{8,9} physical difficulty,⁸ and increased all-cause mortality.^{6,10} Height loss occurring with ageing can be caused by narrowing of vertebral disc, vertebral compression fracture, or senile postural changes.^{11,12} Height loss could serve as a clinical sign to identify vertebral fracture, which is a common but asymptomatic and underdiagnosed osteoporotic fracture in older women. Early identification of height loss risk factors and implementation of preventive treatments may be useful in ameliorating height loss and its related comorbidity and mortality.

Few studies have assessed the risk factors for height loss in the elderly thus far or specifically looked at predictors of height loss, especially factors other than low BMD. Height loss is typically measured as the difference between self-reported recalled maximum height and current measured height, which is prone to recall bias because people tend to overestimate their height.¹³ In this study, we aimed to identify a set of variables that could be used to predict risk of height loss using data from the Buffalo Osteoporosis and Periodontal Disease (OsteoPerio) Study. Height loss was determined as the difference between two height measurements conducted at the clinical visits five years apart using a fixed stadiometer and standardized measurement protocols. The OsteoPerio study is an ancillary study of the Women's Health Initiative Observational Study (WHI-OS), a national prospective study investigating major causes of morbidity and mortality in postmenopausal women.

Methods

Participant population

From 1994 through 1998, a total of 93,676 postmenopausal women aged 50–79 years were enrolled into WHI-OS at 40 clinical centers across the U.S. via mass mailing, phone calls and community presentations. Three years later, the WHI-OS participants at the Buffalo Clinical Center (n=2,249) were invited to join the OsteoPerio Study, which was a prospective cohort study originally designed to investigate the association between osteoporosis and periodontal disease in community-dwelling postmenopausal women. Details in recruitment of these women have been previously described.^{14,15} Exclusion criteria included presence of less than 6 natural teeth at baseline enrollment, known bone disease (excluding osteoporosis) or bilateral hip replacement, a diagnosis of cancer in the past 10 years, and diagnosis of other serious illnesses. A total of 1,362 postmenopausal women completed the OsteoPerio baseline visit, among which 1,341 completed questionnaires and underwent oral and physical examinations. These women were followed up and invited to revisit the clinic five years later to investigate predictors of oral bone loss. Of the 1,341 baseline participants, 101 were ineligible for the follow-up study (due to development of cancer, immunosuppressive disorders, long-term use of antibiotics, or

exposure to dental x-rays in the prior year), 51 were deceased, 151 were no longer interested, 3 withdrew from the WHI-OS, and 9 could not be reached. We further excluded 2 women who had missing height data, yielding 1,024 postmenopausal women in this analytic sample (Figure 1). All participants provided signed informed consent for the WHI-OS and the two OsteoPerio ancillary study visits. All studies were approved by the University at Buffalo Institutional Review Board.

Anthropometric measures and other variables

Participants were given questionnaires regarding their demographics, lifestyle, medical history, medication use, and dietary habits at the baseline visit. Information on demographics and lifestyle were obtained from self-administered WHI questionnaires. A medication inventory of all regularly used medications was taken at baseline; in order to do so participants were instructed to provide containers of all their medications taken at least twice per week during the previous two weeks. Dietary intake was measured with the food frequency questionnaire, developed and validated for use in WHI.¹⁶ Medical history and dental questions were queried using the OsteoPerio Study questionnaire. At both baseline and year-5 visits participants were measured for height, weight, hip and waist circumferences by trained staff according to standardized protocols. Height was measured using a wall-fixed stadiometer (Perspective Enterprises, Kalamazoo, Michigan). Each participant removed her shoes before height was measured. The participant was instructed to stand erect, with the back of her head, back, and buttocks touching the measuring board, with her weight distributed evenly across both feet and her feet flat on the floor with both heels together. In the case of extreme kyphosis, the height was measured with the participant standing in a sideways position. Height was measured to a tenth of a centimeter. Height loss was calculated by subtracting the height measured at the year-5 follow-up visit from the height measured at the baseline visit. We chose a loss of 1 inch (2.54cm) or more over 5-years for marked height loss based on findings from two previous studies relating mortality to height loss.^{6,10} Weight was measured with a calibrated Health O Meter scale (Health O Meter Inc., Bridgeview, Illinois). Hip/waist ratio was calculated from standardized hip and waist circumference measurements. Body mass index (BMI) was calculated from an individual's weight in kilogram divided by the square of height in meter. Bone mass density (BMD) of the anterior-posterior (AP) spine, hip, forearm, femur neck and whole body was measured via dual energy x-ray absorptiometry scan (DXA) (HologicQDR-4500A; Hologic, Inc., Waltham, Massachusetts) at the baseline visit. The oral examination was completed by trained and calibrated dental hygienists to determine various oral health measures such as number of lost teeth.

Other variables from the questionnaires that were considered to be associated with height loss included the following: demographic and anthropometric factors including age at visit, marital status (yes, no), race/ethnicity (White, other), highest level of education (high school, college, post college) and self-reported height at age 18; dietary factors including alcohol consumption (servings/week), total energy consumption (kcal/day), dietary protein intake (g/day), dietary fat intake (g/day), dietary phosphorus intake (mg/day), calcium intake from diet and supplements (mg/day), vitamin D intake from diet and supplements (IU/day), and caffeine intake (mg/day); reproductive variables including years since menopause and

ever been pregnant (% yes); Medical history including history of diagnosis of osteoarthritis, cancer (excluding non-melanoma skin cancer), fracture after age 40, rheumatoid arthritis, and osteoporosis; baseline use of medications including corticosteroids (oral or inhaled, oral only), hormone therapy, and use of bisphosphonates (Alendronate and Raloxifene); lifestyle factors including smoking status (never, former, current), lifetime pack-years of smoking, energy expenditure (total metabolic equivalent task (MET) hours per week) from total exercise, walking, strenuous exercise, as well as strenuous exercise at age of 18, 35 and 50 at least three times per week (% yes).

Statistical analysis

Independent t-tests and Chi-square tests were performed to assess differences in distribution of participant characteristics according to height loss categories (height loss < 1 inch (<2.54 cm) versus height loss ≥ 1 inch (≥ 2.54 cm)). Variables associated with height loss ≥ 1 inch at the p value < 0.20 were considered to be included in the regression model as potential predictors. Stepwise Logistic Regression was used for variable selection. Variables that were significantly associated with height loss ≥ 1 inch at the p value < 0.05 were selected in the multivariable-adjusted model 1. After the model 1 was built, a second set of multivariable-adjusted models were built by additionally assessing whole body or site-specific BMDs that were associated with height loss ≥ 1 inch at the p value < 0.20 in bivariate analysis. Odds ratios (OR) and 95% confidence intervals (CI) of the associations between the predictors and height loss ≥ 1 inch were estimated. Model fit was tested using the Hosmer-Lemeshow test. The prediction accuracy of the logistic regression models was assessed by receiver operating characteristic (ROC). All analyses were performed using the Statistical Package SAS® (version 9.3; SAS Institute, Cary, NC, USA).

Results

A total of 1,024 postmenopausal women were included in these analyses. Overall, participants had a mean age of 65.9 (SD=6.7) years. The majority of participants were White (97.9%), 1.4% were black, <1% other. The mean height loss was 0.4 (SD=0.7) inches during an average 5.1 (SD=0.4) years of follow-up. There were 70 women (6.8%) who lost their height ≥ 1 inch, and these women were significantly older than women who lost their height <1 inch.

Compared to those with <1 inch of height loss, people who lost ≥ 1 inch were significantly different in age, weight at baseline, waist/hip ratio, BMI, alcohol intake, years since menopause, diagnosed/treated for osteoarthritis, baseline use of oral corticosteroids, estrogen therapy, energy expenditure (MET-hours/week) from total exercise, forearm BMD (P values <0.05 for all, Table 1). Factors associated with height loss ≥ 1 inch in bivariate analysis at the p value < 0.20 level and therefore considered in the multivariate regression model included age at baseline, height at 18 years of age, weight at baseline, waist/hip ratio, BMI at baseline, alcohol intake, dietary caffeine intake, dietary protein intake, ever been pregnant, years since menopause, number of teeth present, energy expenditure (MET-hours/week) from total exercise, walking, total strenuous exercise, strenuous exercise ≥ 3 times/week at age 18, 35 and 50, baseline use of oral corticosteroids, oral or inhaled

corticosteroids, estrogen therapy, use of progesterone, diagnosed/treated for osteoarthritis, as well as BMD of whole body, total hip, and forearm. The variables, except for BMD measures, were assessed in a multivariable logistic regression model. Among them, age at baseline (OR=1.11 per 1 year increase in age, 95% CI: 1.06-1.16), weight at baseline (OR=1.05 per 1 kilogram increase in weight, 95% CI: 1.03-1.07), use of oral corticosteroids at baseline (OR= 4.96, 95% CI: 1.25-19.72), and strenuous exercise 3 times/week at age 18 (OR= 0.55, 95% CI: 0.31-0.98) were significantly associated with height loss 1 inch at $P < 0.05$ level and therefore were selected in the prediction model 1 (Table 2). The area under ROC of model 1 was 72.1%, meaning the model was fair in differentiating those who had marked height loss from those who did not. The global fit of the logistic model assessed by Hosmer-Lemeshow test signified good fit of the model ($P = 0.11$).

A second set of models were built by adding whole body BMD, total hip BMD, or forearm BMD in addition to those readily attainable variables in model 1. None of these BMD measures were significantly associated with height loss 1 inch (Table 2). Adding BMD measures did not improve the prediction accuracy of model 1 (Area under ROC of model 1 + BMD measures vs. Area under ROC of model 1: $P > 0.05$ for all).

Discussion

In a large cohort of postmenopausal women, we observed a mean height loss of 0.4 (SD=0.7) inch and 6.8% of women lost their height 1 inch during 5 years of follow-up. Several studies have investigated risk factors for height loss in older women.¹⁷⁻²¹ Nevertheless, the set of variables that could discriminate those with marked height loss was unclear. Our study identified a prediction model for height loss with readily attainable predictors including age, weight, oral corticosteroid use, and strenuous exercise at 18.

The associations of increasing age and oral corticosteroid use with height loss observed in this study are in line with previous findings. It has been well documented that age is an important determinant for height loss, which could occur after 43 years of age for women,² and accelerates with aging.³ Intervertebral discs lose water content while aging and thereby become thinner. In addition, the risk of vertebral fracture, a known reason for height loss, also increases with age.^{22,23} There has been limited research investigating the association between oral corticosteroids use and height loss. A previous study reported a 1.7-fold (95% CI: 1.3-2.2) increased odds of height loss of greater than 2.5 cm (one inch) among participants with lung diseases taking oral corticosteroids compared to controls,²⁴ where height loss was calculated from reported height at age 25 years minus measured height at the study visit. In our study conducted in a cohort of community-dwelling postmenopausal women, baseline oral corticosteroids use was found to be associated with a nearly 5-fold increase in risk of 5-year height loss 1 inch.

In addition, our study found women who reported doing more strenuous exercise at age 18 had a nearly 50% decreased odds of marked height loss over 5 years. Physical activity has been linked to higher bone density and reduced rate of bone loss among the elderly.²⁵ A previous study comparing height loss over 30 years between physical active and physical inactive elderly found that moderate-vigorous physical activity throughout lifetime reduced

height loss in both men and women.¹⁸ Another clinical trial reported that a six-month home based exercise program may slow down height loss among postmenopausal women with osteoporosis and at least one vertebral fracture.²⁶ The inverse association between strenuous exercise at young age and postmenopausal height loss observed in our study may be explained by the beneficial effect of physical activity on peak bone density achieved at early life. Peak bone density is an established protective factor for age-related bone loss and fragility fractures.²⁷ Additional studies are needed to clarify the role of early-life physical activity in height loss as people age.

It is surprising that a positive association between weight and height loss risk was observed in our study. A previous study reported that high body weight was protective against height loss in postmenopausal women.¹⁷ Moreover, decreasing weight has been associated with greater bone loss in older women, which is possibly due to reduced dietary calcium intake as well as hormonal changes including decrease in bone-active hormones (e.g. estrogens and leptin) and increase in hormones that stimulate osteoclast function (e.g. cortisol).²⁸ This unexpected finding could be explained by unfavorable effect of weight on factors leading to height loss other than low BMD. Results from a cohort study in middle aged women showed that high BMI was a predictor for development of disc degeneration, a disease with diminished disc height.²⁹ Moreover, the positive association between weight and height loss may due to the adverse effect of body fat on BMD. Fat mass, a major component of body weight, has been found to be inversely associated with spinal BMD after adjusting for weight.³⁰ In addition, the study reported that the negative effect of abdominal fat is more prominent than limb fat on BMD in women,³⁰ which is supported by our finding showing higher waist/hip ratio in people with greater height loss. Abdominal fat produces a variety of bone active hormones, and is associated with insulin resistance that has negative influence in BMD.³¹ Further investigation is warranted to support the association between weight and height loss beyond its weight-bearing benefits on BMD.

Participants with height loss ≥ 1 inch had lower whole body BMD and site-specific BMD measures compared to those without in bivariate analysis. However, baseline BMD measures were not significantly associated with height loss ≥ 1 inch in the multivariable-adjusted models. We did not assess change in BMD measures over time. Moreover, adding BMD measures did not significantly improve prediction accuracy of the model in addition to age, weight, oral corticosteroid use, and strenuous exercise at age 18. Higher BMD was associated with less height loss in the forearm ($p<0.01$) and total body ($p=0.06$) in univariate analyses, however these associations did not add to the predictive models once other factors were included. Although previous studies have reported that osteoporosis is an independent risk factor for height loss in postmenopausal women,^{7,19} these studies assessed height loss based on self-reported heights rather than measured heights as we performed in the present study. The limited associations between BMD measures and height loss may also be due to a relatively short period of height loss of our participants.

Some limitations of this study should be noted. The majority of the study population were white, well-educated, and health-conscious postmenopausal women. Study results may not be generalizable to populations with different characteristics. Strenuous exercise at age 18 was obtained from self-reported questionnaires; misclassification on this variable is

therefore inevitable. However, physical activity assessed using the study questionnaire has been shown to be reproducible and correlated with criterion measures.^{32,33} In addition, because physical activity assessment preceded occurrence of height loss, misclassification should be non-differential and would be expected to bias the estimates towards null. Furthermore, although we measured prospective height loss, the total height loss throughout life cannot be determined given the limited follow-up period. We also cannot determine whether physical activity at age 18 is a causal factor, or reflects a generally healthier lifestyle that is influencing height loss at later ages.

Strengths of this study included large sample size, high retention rate, and extensive information on potential risk factors obtained through questionnaires and physical examination. In addition, height loss was calculated based on prospectively measured heights according to the same standardized protocols by trained clinical staff. Objective measure of height loss minimized information bias. Moreover, the prospective nature of this study allowed for determination of the temporality of the predictors and height loss. The results may have specific relevance to later down-stream outcomes, such as fracture and mortality. We determined factors associated with a height loss of 1 inch or more. Previous studies have determined height losses of 2 cm in mid-life and 2 inches over 15 years (similar to height loss determined in our study) were associated with increased mortality.^{6,10} Masunari et al (2011) found a 2 cm loss associated with a 76% increased risk of mortality in a cohort of Japanese men and women.¹⁰ Using data from the Study of Osteoporotic Fracture (SOF), Hillier found loss of 2 inches or more over 15 years was associated with a 50% increased risk of fracture and death over the next 5 years.⁶ Given this, our findings may be useful not only in helping to identify factors that predict risk for height loss in older women, they may also help practitioners target women earlier at risk of later fracture and mortality.

Conclusions

In summary, we found a set of variables including age, weight, use of oral corticosteroids, and strenuous exercise at age 18 that had fair ability to discriminate postmenopausal women who experienced height loss 1 inch from those who did not. Adding BMD measures did not increase the prediction accuracy of this algorithm appreciably. Additional studies are warranted to validate this model in other independent populations before its use in primary care settings. However, this prediction model may be useful not only in identifying women at risk of height loss where interventions may be useful, it is possible that earlier identification and treatment of these women may have potential for down-stream impact on consequences of height loss in elderly women, including fracture and mortality.

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Figure 1.
Flowchart of the study participants

Table 1

Height loss according to participant characteristics: The OsteoPerio Study (n=1,024)

	Height loss <1 inch		Height loss 1 Inch		p-value ^d
	n	Mean(SD)	n	Mean(SD)	
Demographics					
Age at baseline visit	954	65.6(6.6)	70	69.6(6.7)	<0.001
Married (N(%))	954	667(69.9)	70	51(72.9)	0.763
White (N(%))	954	936(98.1)	70	67(95.7)	0.306
Highest level of education	935		70		0.426
High School (N(%))		198(21.2)		15(21.4)	
College (N(%))		402(43.0)		35(50.0)	
Post College (N(%))		335(35.8)		20(28.6)	
Anthropometric measures					
Height at baseline(cm)	954	163.1(5.9)	70	163.0(6.4)	0.869
Height at 18 years (cm)	950	163.8(6.6)	69	164.9(5.9)	0.186
Weight (kg)	954	70.3(13.6)	70	74.5(15.7)	0.015
Waist/hip ratio	907	0.80(0.1)	67	0.82(0.1)	0.007
Body mass index (kg/cm ²)	954	26.5(5.0)	70	28.1(6.3)	0.008
Dietary intake					
Alcohol consumption (servings/week)	922		69		0.031
0 servings (N(%))		294(31.9)		32(46.4)	
1-<2 serving (N(%))		320(34.7)		22(31.9)	
2 servings (N(%))		308(33.4)		15(21.7)	
Total energy consumption (Kcal/day)	922	1551.6(530.0)	69	1479.9(510.6)	0.278
Dietary protein (g/day)	922	65.8(25.1)	69	61.1(21.5)	0.133
Dietary fat (g/day)	922	53.7(26.7)	69	51.2(20.7)	0.457
Dietary Phosphorus (mg/day)	922	1150(462.1)	69	1100.98(445.8)	0.386
Dietary Calcium FFQ (mg/day)	926	779.1(428.0)	69	746.5 (374.2)	0.539
Dietary Vitamin D FFQ (IU/day)	925	199.2(128.0)	69	186.4(99.8)	0.421
Calcium from supplements (mg/day)	954	586.1(564.2)	70	650.1 (937.0)	0.533
Vitamin D from supplements (IU/day)	953	299.4(279.4)	70	322 (335.4)	0.885

	Height loss <1 inch		Height loss 1 Inch		p-value ^d
	n	Mean(SD)	n	Mean(SD)	
Dietary caffeine (mg)	922	169.6(128.4)	69	193.8(134.3)	0.132
Reproductive					
Years since menopause	954	17.67(8.3)	70	21.51(9.4)	<0.001
Ever been pregnant (N(%))	952	851(89.4)	70	59(84.3)	0.187
Dental variables					
Any tooth loss (N(%))	954	778(81.6)	70	62(88.6)	0.140
Number of teeth present	954	23.5(5.2)	70	21.9(6.0)	0.010
Medical History					
Diagnosed/treated for osteoarthritis (N(%))	954	219(23.0)	70	24(34.3)	0.032
Diagnosed with cancer (N(%))	954	72(7.6)	70	4(5.7)	0.572
Personal history of fracture after age 40 (N(%))	954	299(31.3)	70	27(38.6)	0.210
Diagnosed with rheumatoid arthritis (N(%))	954	55(5.8)	70	5(7.1)	0.636
Ever diagnosed with osteoporosis (N(%))	921	119(12.5)	70	12(17.1)	0.264
Medication use at baseline					
Oral or inhaled corticosteroids (N(%))	949	74(7.8)	70	9(12.9)	0.135
Oral corticosteroids (N(%))	949	10 (1.1)	70	5 (7.1)	<0.001
Estrogen therapy (N(%))	949	482(50.8)	70	23(32.9)	0.004
Progesterone (N(%))	949	240(25.3)	70	11(15.7)	0.073
Alendronate(Fosamax) (N(%))	949	62(6.5)	70	6(8.6)	0.510
Raloxifene (Evista) (N(%))	949	14(1.5)	70	2(2.9)	0.369
Smoking history					
Cigarette smoking status	954		70		0.857
Never (N(%))		515(54.0)		40(57.1)	
Former (N(%))		414(43.4)		28(40.0)	
Current (N(%))		25(2.6)		2(2.9)	
Lifetime pack-years of smoking	936	9.6(17.4)	69	10.4(18.0)	0.712
Physical activity					
Total exercise (MET-hour/week)	928	14.5(14.7)	69	11.2(12.7)	0.041
Walking (MET-hour/week)	928	4.5(5.8)	69	3.2(4.7)	0.054
Strenuous exercise (MET-hour/week)	928	4.2(8.6)	69	2.6(8.1)	0.052

	Height loss <1 inch		Height loss 1 Inch		p-value ^a
	n	Mean(SD)	n	Mean(SD)	
Strenuous exercise 3 times/week at 18years (N(%))	939	394(42.0)	68	23(33.8)	0.188
Strenuous exercise 3 times/week at 35years (N(%))	944	368(39.1)	69	21(30.9)	0.176
Strenuous exercise 3 times/week at 50years(N(%))	944	334(35.4)	69	17(24.6)	0.070
BMD at Baseline					
Whole body (g/cm ²)	949	1.06(0.11)	66	1.04(0.12)	0.064
Total Hip (g/cm ²)	948	0.87(0.13)	64	0.84(0.15)	0.185
Neck of Femur (g/cm ²)	948	0.73(0.12)	64	0.71(0.12)	0.254
Forearm (g/cm ²)	951	0.52(0.07)	68	0.49(0.08)	<0.001
AP spine (g/cm ²)	807	0.92 (0.2)	36	0.90(0.17)	0.317

Data is expressed as Mean (SD) unless otherwise indicated

^a p-values comparing loss in height are t-test for continuous variables and chi-square test for categorical variables

Table 2

Factors associated with 1 inch of height loss over 5 years in postmenopausal women: The OsteoPerio Study

	Model 1 + whole body BMD			Model 1 + hip BMD			Model 1 + forearm BMD		
Baseline characteristics	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	P-value
Age (per 1 yr increase)	1.11 (1.06-1.16)	<0.001	1.10 (1.05-1.15)	<0.001	1.10 (1.05-1.15)	<0.001	1.09 (1.04-1.15)	<0.001	<0.001
Weight (per 1 Kg increase)	1.05 (1.03-1.07)	<0.001	1.05 (1.03-1.07)	<0.001	1.05 (1.03-1.07)	<0.001	1.05 (1.03-1.07)	<0.001	<0.001
Oral Corticosteroid Use at Baseline (yes)	4.96 (1.25-19.72)	0.023	4.64 (1.15-18.64)	0.031	4.86 (1.21-19.51)	0.026	4.46 (1.10-17.99)	0.036	0.036
Strenuous Exercise at age 18 (yes)	0.55 (0.31-0.98)	0.043	0.56 (0.31-1.01)	0.054	0.56 (0.31-1.00)	0.051	0.56 (0.31-1.01)	0.055	0.055
Whole body BMD (per g/cm2 increase)			0.17 (0.01-2.67)	0.208					
Total Hip BMD (per g/cm2 increase)					0.12 (0.01-1.35)	0.087			
Forearm BMD (per g/cm2 increase)							0.05 (<0.001-5.53)	0.214	
	Chi-Square	p-value	Chi-Square	p-value	Chi-Square	p-value	Chi-Square	p-value	p-value
Hosmer-Lemeshow Test	13.12	0.11	11.24	0.19	26.18	0.001	14.78	0.064	
	AUROC (95% CI)		AUROC (95% CI)		AUROC (95% CI)		AUROC (95% CI)		AUROC (95% CI)
Prediction Accuracy	72.1% (64.4%-79.7%)		72.3% (64.7%-79.9%)		72.9% (65.2%-80.7%)		72.4% (64.7%-80.1%)		72.4% (64.7%-80.1%)

BMD: Bone mass density

AUROC: Area under the receiver operating characteristic curve